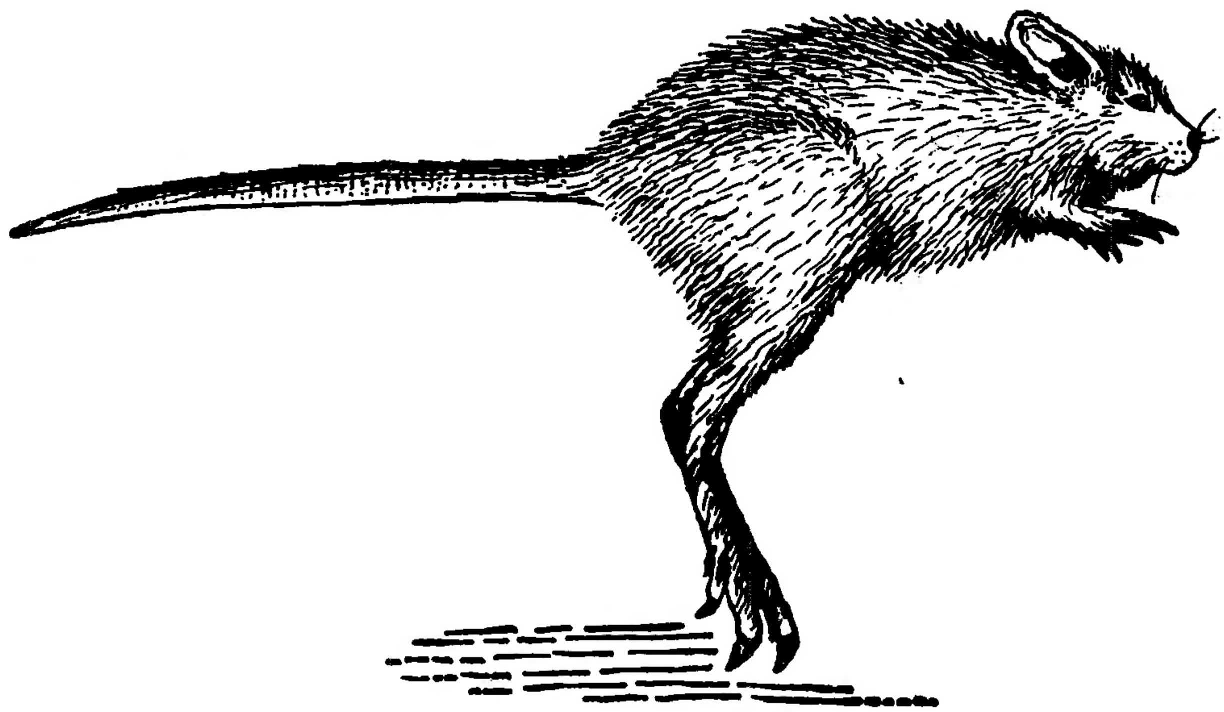
VOLUME 14 No. 1
1961



RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

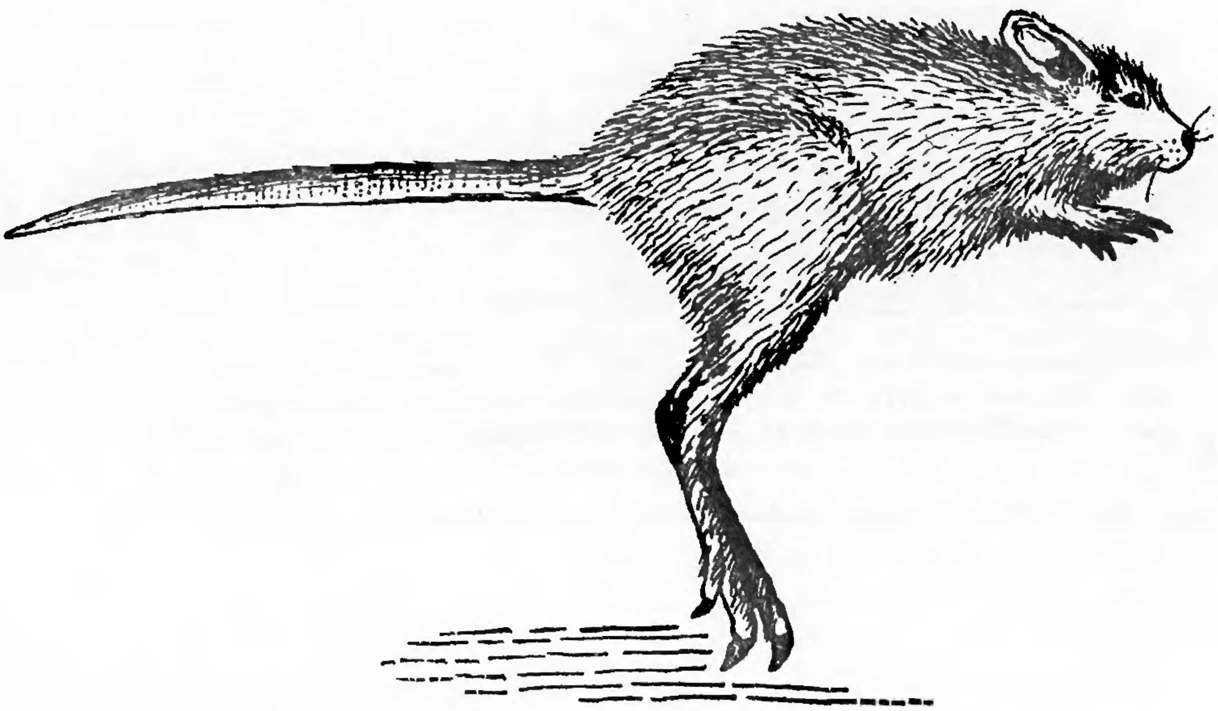
Graeme Pretty
9-1-62

Published by the Board and edited by the Museum Director

Printed in Australia by W. L. Hawes, Government Printer, Adelaide.
Registered in Australia for Transmission by Post as a Periodical.

VOLUME 14

1961-1964



RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

Published by the Museum Board and edited by Norman B. Tindale

Printed in Australia by W. L. Hawes, Government Printer, Adelaide, South Australia

The title page design incorporates a sketch by Madeleine Boyce of *Caloprymnus campestis*, a rare species of rat kangaroo, once considered extinct, but rediscovered in the Lake Eyre Basin some years ago by the Honorary Curator of Mammals (Mr. H. H. Finlayson)

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No. 3. Published 23rd August, 1963

No. 4. Published 27th May, 1964

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BY H. M. COOPER, HON. ASSOCIATE IN ANTHROPOLOGY,
SOUTH AUSTRALIAN MUSEUM

Summary

This paper describes the various shapes and forms of the hammer-stones of South Australia. It is suggested that lack of sufficient evidence at the present time precludes the definite separation of the different types of this implement – so essential an aid to stone age man – either into their correct material culture sequences, if any, or to define many of their possible uses.

Herbert Mathew Hale, O.B.E.

Director of the South Australian Museum from 1928 until his retirement in 1960.

ABORIGINAL HAMMER-STONES OF SOUTH AUSTRALIA

By H. M. COOPER, Hon. Associate in Anthropology, South Australian Museum

Fig. 1-29

SUMMARY

This paper describes the various shapes and forms of the hammer-stones of South Australia. It is suggested that lack of sufficient evidence at the present time precludes the definite separation of the different types of this implement—so essential an aid to stone age man—either into their correct material culture sequences, if any, or to define many of their possible uses.

DESCRIPTION AND GENERAL DISCUSSION

The writer, so far as his search has extended, failed to discover any paper devoted solely and in detail to our local hammer-stones although many references to them have appeared in various papers relating to South Australian stone implements by Howchin (1934), and Tindale and Maegraith (1931).

The opportunity afforded by the examination of several thousand examples in the South Australian Museum together with the collection, personally, of many hundreds in the field, suggested the possible usefulness of a paper describing a representative series of types and their variants.

It has been deemed preferable to refer solely to those from South Australia owing to the possible existence of additional types elsewhere in Australia (due to wide differences in its flora and fauna, which exist in such a vast territory) and, in addition, local variations unknown to the writer which doubtless occur.

Lack of much undisputable evidence in many cases tends to advise the exercise of caution towards any arbitrary attempt to place our hammer-stones in any definite material culture sequence, if indeed any major changes have occurred during the antiquity of man in Australia. It appears probable, however, that the hammer-stone, which persisted into historic times and was indispensible in the every day life of primitive man, had continued to exist throughout his material culture periods in its fundamental conception although subject to some modifications in design and size as necessitated by his subsequent change to many much lighter and smaller implements and also to alterations in the flora and fauna provoked by his arrival in Australia.

The principal need for the hammer-stone was a tool for the manufacture of his stone implements. These implements could be divided, broadly, into two groups—*core* and *flake* implements. A hammer was held in one hand and in the other the workman grasped another rock destined to produce a stone implement. The former, more especially in early periods, could have been a fairly heavy stone or water-worn pebble because at that time he depended largely upon the weight of his implement for cutting and chopping. Sharp and skilfully aimed blows, struck with his hammer-stone, in the correct plane, removed unnecessary material in the form of flakes from the latter, and so provided him with a base of the required weight and form for his crude implement.

Any sharp edged stone could serve as a cutting tool. However, the working edges of the more refined examples were then improved by means of secondary trimming, that is small flakes were more carefully removed along them by means of hammer-stones, making his large implement more efficient. This technique of removing flakes from a block of stone or a pebble produced a *core* implement.

The manufacture of a *flake* implement was commenced in the same way, that is with a hammer-stone held in one hand and a block of suitable stone in the other. In this case, however, the block of stone itself, instead of being trimmed to form an implement, was used to provide flakes of the required size, shape and thickness, by striking it in the correct place and thus breaking off flakes of the desired dimensions. These were then, during later periods at least, carefully given light secondary trimming along their working edges to provide efficient tools such as small knives, saws, scrapers or adzes. The smallest microlith flake implements of South Australia weigh no more than .2 of a milligram.

The hammer-stones of South Australia, as elsewhere, at least where an abundance of material was available, were selected from examples possessing shapes that could be grasped conveniently in the hand. Smooth water-worn pebbles were sought after wherever possible; their surfaces tended to minimize injuries to the hand during use. Angular blocks with rounded edges and even rough pieces were sometimes employed, especially in those situations where more suitable material was lacking.

The large majority of South Australian hammer-stones comprise (1) discoidal and (2) ovate shaped water-worn pebbles, the material employed, chiefly, being fine-grained quartzites very compact in texture and eminently suitable for the purpose. Other rocks used include granitic types, flint, chert, fossiliferous Cambrian limestone and silicified sandstones. Hammer-stones with the slightest indications of wear, due perhaps to use upon no more than a single occasion, are very plentiful in areas where pebbles abound such as upon the banks of the River Wakefield (Cooper 1960) and in the vicinity of Cape Jervis, but in districts where good material was scarce or entirely absent and supplies had to be transported or traded, hammer-stones often exhibit extreme wear suggesting that they were highly valued and jealously guarded. Cooper (1954) discussed a similar situation relating to adzestones, those in localities where suitable material was lacking, being trimmed again many times until completely unserviceable, whereas those in areas with a plentiful supply of raw material were rejected as soon as partly worn and replaced by new ones. These two examples serve to indicate that even primitive man had his own particular economic problems.

The hammer-stone, in common with many other stone implements, appears to have been employed for a variety of purposes, mostly subsidiary, in addition to its primary function in the manufacture of stone implements. An examination of the collection indicates their use at times for such supplementary requirements as pounders and anvils. Some of the secondary purposes, more particularly in the earlier periods, can be assumed at present as merely conjectural but it is known that in historic times they were utilized in various ways such as for pounding nuts, bark, skins and in the recovery of marrows contained in bones. Hammer-dressing of polished stone axe-heads, in order to complete their trimming, was possibly another well defined purpose. Crushed shells of periwinkles and other sea species, from which it is difficult to extract the edible contents by other means, have been discovered upon kitchen middens on Kangaroo Island (Cooper 1943) and upon the adjacent main. Hammer-stones would provide the logical means for effecting this end.

It is believed that, prior to the use of hammer-stones as an established material culture industry, primitive man, in at least some parts of the world manufactured his crude implements by simply striking or hurling a block of stone against a rocky face and thus breaking off in a haphazard way, for subsequent use, a portion of the block which he had thrown. It is hardly possible to determine whether this was standard procedure or not during the earlier periods of man's occupation of Australia although it appears to have been employed as a temporary measure during historic times for the manufacture of an occasional crude implement.

Baines in Evans (1872) records a further interesting method of producing flake implements witnessed by him near Victoria River, North Australia, during 1860. A native struck a piece of stone "as big as an ostrich egg" held in the hand against a large rock with such skill as to produce a perfectly symmetrical flake with a strengthening midrib, its finished form indicating the removal of only three flakes in all for its production. This implement, owing to its design and locality of origin, appears to have been an interchangeable one used in that part of Australia as a spear-head, a knife, or a pick.

The large accumulation of hammer-stones upon camp-sites in many parts of South Australia, however, seems to offer sufficient proof that they provided the means utilized in the shaping and formation of the majority of that State's stone implements including many types which occur in thousands and are so standardized in form that haphazard methods of manufacture would be impracticable.

Alternative implements to replace the conventional hammer-stone, possibly utilized merely as a temporary measure, are indicated by the presence of occasional discarded working cores of convenient size with evidence upon their surfaces of hammering and battering (fig. 26). Many hand pebble choppers of the dominant Kangaroo Island industry bear extensive evidence of use upon their nether sides which show numerous traces of deep pitting over a considerable area, apparently the result of use as temporary hammers. (Cooper 1943), (fig. 27). A few of the large implements from Hallett Cove (Cooper 1959) bear similar indications and also others, in addition, from the River Wakefield area (Cooper 1961).

A careful survey of the thousands of South Australian hammer-stones already referred to disclosed that it was difficult, confusing, and even impracticable to separate, arbitrarily, all conventional hammer-stones, from a considerable proportion of pebble upper millstones, anvils and pounders because in many cases the three latter groups had been used, apparently, when the necessity arose, to perform the functions of a hammer-stone in addition to their own. Examples of all three have been included in this paper. All types, to some degree, tend to merge into one another.

A typical hammer-stone from South Australia may be described as a smooth water-worn pebble, symmetrically ovate in natural shape and derived from rock of sufficient strength to resist the wear and stresses to which an implement of this nature is liable. These hammer-stones exhibit degrees of battering and pitting from the very slightest surface markings through all the respective stages to extreme wear when the pebble is finally reduced from a rounded to an almost rectangular shape (fig. 1, 2 and 3). The wear, doubtless the result of diverse uses, is practically always evident upon the middle of both sides, both ends and all edges. Well developed pit holes develop, generally in pairs, the one above the other just higher and lower than mid-centre. Their existence in this interesting manner appears to be due to the operator turning the hammer-stone end for end from time to time when using either one or the other of the two sides. They are usually fairly similar in depth or nearly so. This may suggest that the reversal of end was deliberate and not accidental because such intentional action would tend to retain a better balance and extend, in addition, the useful life of the stone.

Dual deep grooves, due to battering, upon both edges of certain hammer-stones, are found upon a considerable number of ovate examples; they occur, chiefly, upon camp-sites on Yorke Peninsula (fig. 4). The depth of these grooves is roughly equable, which tends to indicate that they were reversed deliberately end for end by the user in much the same way as in the case of the dual depressions upon the two sides already referred to. An interesting variant but not a conventional type of hammer-stone is shown in fig. 5, where the two central pitted or depression centres upon both sides have been made in a transverse but slightly oblique direction instead of the conventional longitudinal position.

The other dominant South Australian hammer-stone, as already stated, is discoidal in shape, its fine grained texture being generally similar to that of the ovate form. It exists in large numbers, as does the ovate type, and similarly bears evidence of use from the slightest to extreme wear. Both sides and the whole of its discoidal periphery (edge) were subject to use. A typical and plentiful well-worn example unlike the ovate type, however, exhibits only a single pit hole or depression at the centre of one or both sides. This could be due to its discoidal shape because the blows of the operator, irrespective of which of the sides was held uppermost would tend to fall in the centre (fig. 6, 7, 8, 9 and 10).

Both ovate and discoidal forms vary greatly in size, more especially the latter and many of them served no doubt as anvils although some of these, in addition, bear evidence of marked use as hammers upon their edges. The central pit mark upon the larger examples is often very deep.

An occasional anvil possesses well defined pit marks, with jagged edges instead of the normally smooth worn sides. This jagged deep pitting also occurs upon small hammer-stones of various shapes but of such a size as suggests use in the hand. This condition seems too harsh to indicate the use of either as a hammer-stone or anvil respectively when used for pounding and breaking, as the case may be, bones, shells or skins. It may be the result of much heavier work such as stone crushing or flaking, perhaps for some specific work, when operating a hammer-stone plus anvil technique (fig. 10 and 11).

Small ovate hammer-stones, such as shown in fig. 12 and 13 occur, almost exclusively, upon camp-sites on the Adelaide Plains, the coastal regions southwards towards Cape Jervis and Yorke Peninsula. Hammering is confined exclusively to the two extremities with no evidence of wear elsewhere. The absence of marks in their middle sections is puzzling and suggests a possibility that they were hafted in some manner.

Fig. 14 shows a hammer-stone made of tough fine grained quartzite with marked evidence of severe end flake damage to itself incurred during use; it is relatively common, more particularly upon the Adelaide Plains and adjacent regions. Stone implements and working cores made from the same hard rock are abundant upon these camping grounds. Such damage to hammer-stones appears to be the result of attempting to strike off flakes from blocks of the same intractable material as that from which the hammers were derived.

Hammer-stones, more elongate than the ovate type described, occur in small numbers. Wear in these examples appears to be mostly upon the extremities suggesting a preference for pounding (fig. 15).

Many polished axe-heads, composed of various igneous rocks from the South-East of South Australia, possess a well defined pit hole upon each side a little above the working edge, probably resulting from use as anvils. Fig. 16 from that area, in addition, exhibits a deeply battered depression upon both edges due to hammering.

Many upper millstones, when made from water-worn pebbles, in addition to possessing the normal nether surface worn smooth by grinding seeds, show distinct evidence of hammering upon the entire periphery of their edges. This implement, therefore, appears to have had at least two important uses (fig. 17).

Long and narrow stones, shown in fig. 18 and 19, nondescript in shape and untrimmed, are found sparingly. They exhibit near one extremity, and usually upon one side only, either a well developed pit hole or a more widespread battered area, due to some form of hammering. They were termed by McCarthy (1946) "Brachinas" from the Far Northern creek, where the first example was found by the writer. Their use must have been restricted to work of a light nature because of the inferior strength of the material composing them and also their long and narrow form (Mountford 1939).

Fig. 20 shows a type of nondescript shape from Kangaroo Island. It is severely weathered, thickly patinated and has an outer coating of lateritic concretion. It weighs 6 lb. There is a somewhat jagged pit hole upon each side. Its chief use could have been as an anvil. Fig. 29 was used, probably, somewhat similarly. Its peripheral edge in addition, however, bears strong evidence that it was also employed as a hammer-stone.

The use or uses of very small hammer-stones—some weighing as little as 1oz.—may be somewhat more difficult to define even although they are often identical with their larger counterparts. It is obvious that their lightness precludes association with any type of work where weight is a consideration. It is possible that they were utilized in the addition of secondary trimming to certain of the smaller types of implements and for the removal of small and frail flakes from working cores in the manufacture of some of the microlith types (fig. 21, 22 and 23).

Fig. 24 and 25 represent a group of Kangaroo Island hammer-stones smaller than those of more conventional size from that locality. They may have been used to fashion stone implements of lesser size such as those described by Cooper (1960).

Fig. 28 illustrates an interesting dual type of implement—of which the South Australian Museum possesses over 80 specimens. It is confined, so far as is known locally at present, to the Far North West of the State and thence across the border into the adjacent districts of Western Australia. Its battered ends indicate extensive use for pounding and hammering. Its other, and obviously chief use, is for employment as a kind of rolling millstone. Mr. N. B. Tindale, Curator of Anthropology, South Australian Museum, has witnessed this latter function in progress and will describe it fully in a later paper.

The writer has not seen any water-worn pebble or other form of rock, where the natural shape has been deliberately altered by chipping, preparatory to its use as a hammer-stone. This, of course, is in marked contrast to the various stone implement industries.

CONCLUSIONS

The two dominant hammer-stone shapes, as described in detail, disclose, it will have been seen, some differences caused by wear. There appears to be very little definite evidence available relating to at least some of these variations, although it is possible that there may have been deliberate and important reasons for selecting the two different shapes, and if this be true they may have at least some different functions. The two extremities of ovate forms, for example, would appear ideal for the purpose of striking the necessary flakes from working cores to shape them into implements or removing flakes from blocks to serve, when completed, as future tools.

The possibility that they represent separate material culture periods could be considered but such a hypothesis seems hardly tenable. Both shapes, more especially the ovate form, exist in association with the large hand pebble choppers of Kangaroo Island left behind by the natives formerly inhabiting that locality but who, apparently, disappeared a considerable time ago.

The question arises, too, whether the earliest primitive man to reach Australia brought with him the knowledge of hammer-stones represented by one or more of the forms discussed herein or whether it reached the continent through the medium of later arrivals. Primeval man, during the earliest periods of his existence, as his native successor of today does as a makeshift, was doubtless content to use any random fragment of rock lying upon the surface of the ground in his domain in order to provide himself with a crude implement with which to cut, saw or chop. He may have devised later, as his experience progressed, one more to his satisfaction by hurling one rock against another and selecting a suitable fragment. He appears to have learned, subsequently, by holding in his hand a stone of suitable size—preferably a water-worn pebble which would obviate cuts and bruises—that it could more easily enable him to fashion a rude implement but an improved one, from a rock of superior material held in the other.

Recent excavations and Carbon 14 datings appear to extend the antiquity of man in Australia to much earlier periods than previously believed possible. It seems fairly certain, however, that Australia's first inhabitants were acquainted with the hammer-stone and its functional use at least in a generalized way. The many thousands of standard examples of the more recent material culture implement types found in Australia indicate that hammer-stones—not haphazard methods—were essential for their production, as already emphasized in this paper.

It may be observed that wear upon the surfaces of the hammer-stones discussed herein is the sole evidence, in many instances, upon which to base even problematical deductions relating to some of their uses, remembering that function is of far greater anthropological significance than mere shape or form. It is most essential, furthermore, in order to minimize possible faulty conclusions, that these deductions should be associated only with those examples belonging to any particular branch of the culture of primitive man, which occur in numbers sufficiently abundant in order to prove, beyond reasonable doubt, their respective existences as distinct well-established types. These conditions appertain to all figured specimens in this paper with the exception of fig. 5 which is described in the text but with the necessary reservations.

Stone, without doubt, did not comprise the only material employed through the ages for the purposes of hammering, pounding and battering. It is logical to assume that wood possessed advantages or at least was suitable for some purposes. The latter of course, with the passage of time, have long since disappeared.

Suitable rock, fortunately, is practically indestructible; nevertheless it is useful to bear in mind that implements made of that material, as for example in the case of our hammer-stones, comprise no more than part of any one of the many particular material cultures of former periods of primeval man.

An examination of the stone implements of Australia, however cursory, cannot fail to emphasize the vital importance of the hammer-stone to the native workman without which he would be as helpless as a skilled tradesman who has mislaid his footrule or his drill. The correct use of this simple tool in the production of flakes having the necessary length, breadth and thickness—more especially when the core to be struck is of equal strength and intractibility—required skill in its initial achievement and in completing the finished product.

An account of the manufacture by a Shasta Indian of California of an obsidian arrow-head derived from a flake—observed by an unnamed writer—is referred to by Stevens (1870) and is deserving of repetition. It reveals the skill needed by the native worker, not only in its final trimming but also in his intimate knowledge of the various types of rock used by him, because in many cases, owing to their varied texture, they did not respond satisfactorily to produce the required flaking unless treated correctly in anticipation of it.

This unknown writer states that a flake having been struck off a block by the native "he commenced a series of continuous blows, every one of which chipped off fragments of the brittle substance. It gradually seemed to acquire shape. After finishing the base of the arrow-head . . . he began striking gentle blows, every one of which I expected would break it in pieces. Yet such was his adroit application, his skill and dexterity that in little over an hour he produced a perfect obsidian arrow-head.

"I then requested him to carve one from the remains of a broken bottle which, after two failures, he succeeded in doing. He gave as a reason for his ill-success that he did not understand the grain of the glass. No sculptor ever handled a chisel with greater precision, or more carefully measured the weight and effect of every blow, than did this ingenious Indian."

The handicraft in stone bequeathed by our own native people of more recent years—still nomadic hunters and food gatherers, as were the many generations which preceded them—cannot fail to disclose the symmetrical beauty of their craftsmanship.

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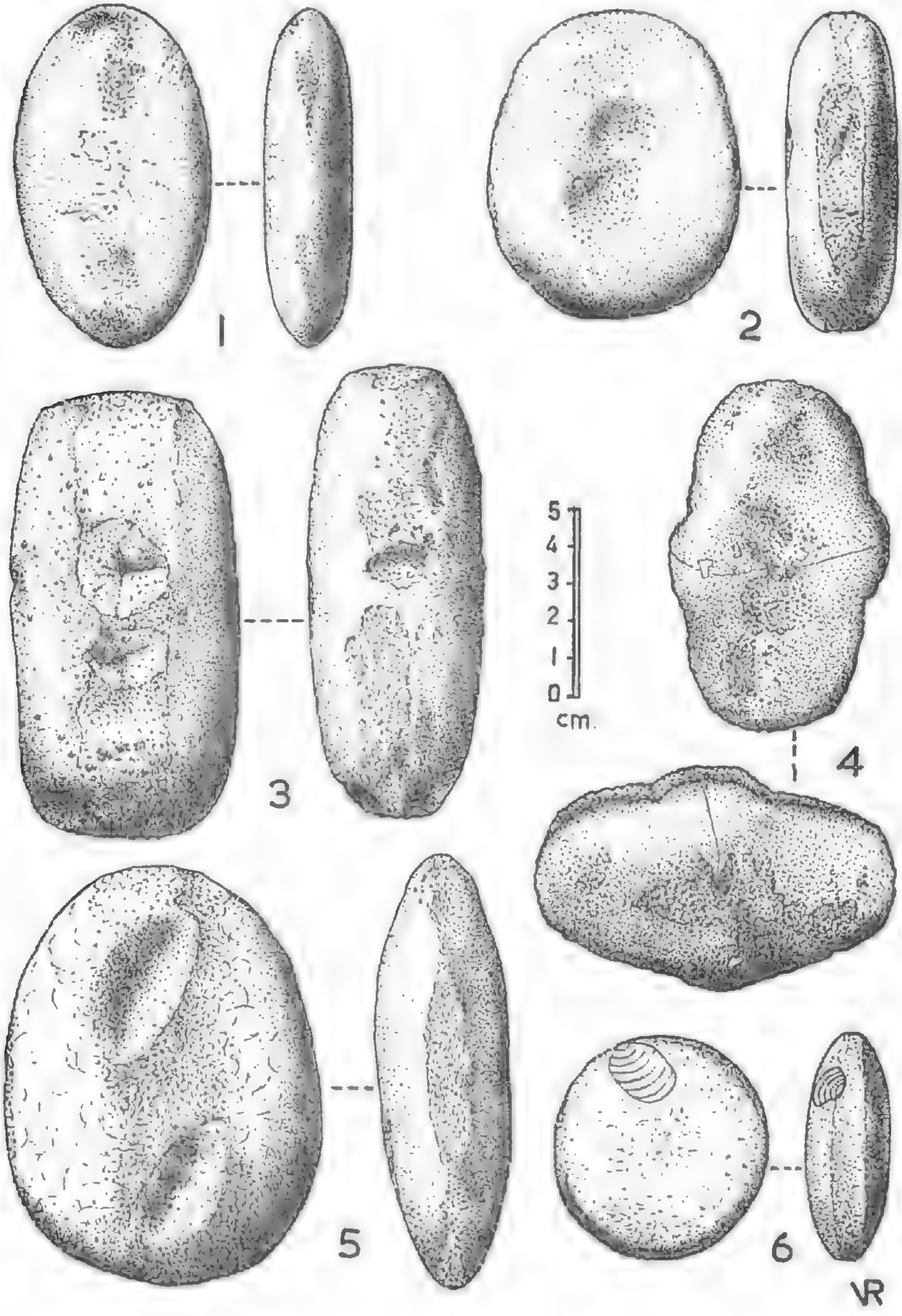
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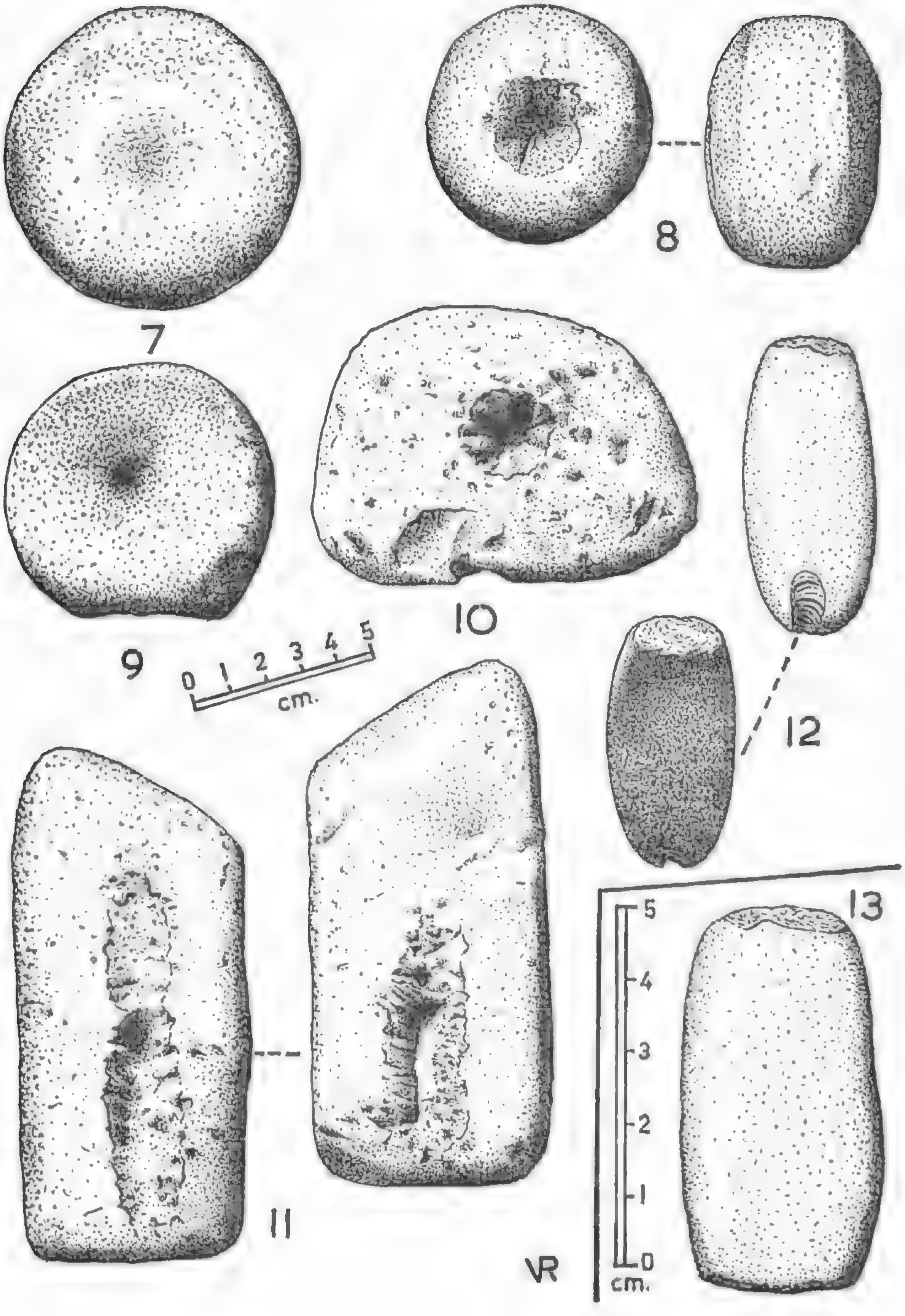
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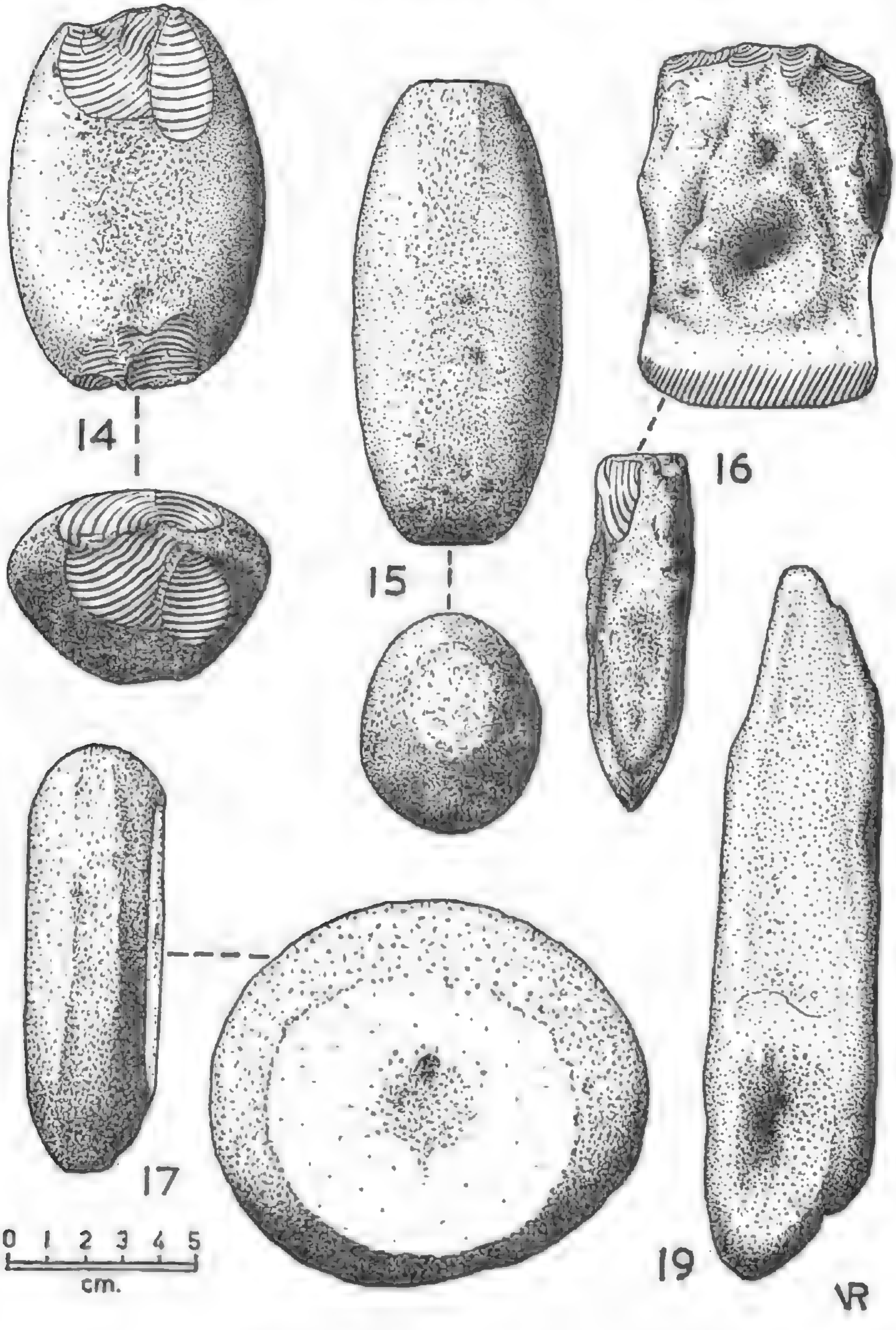
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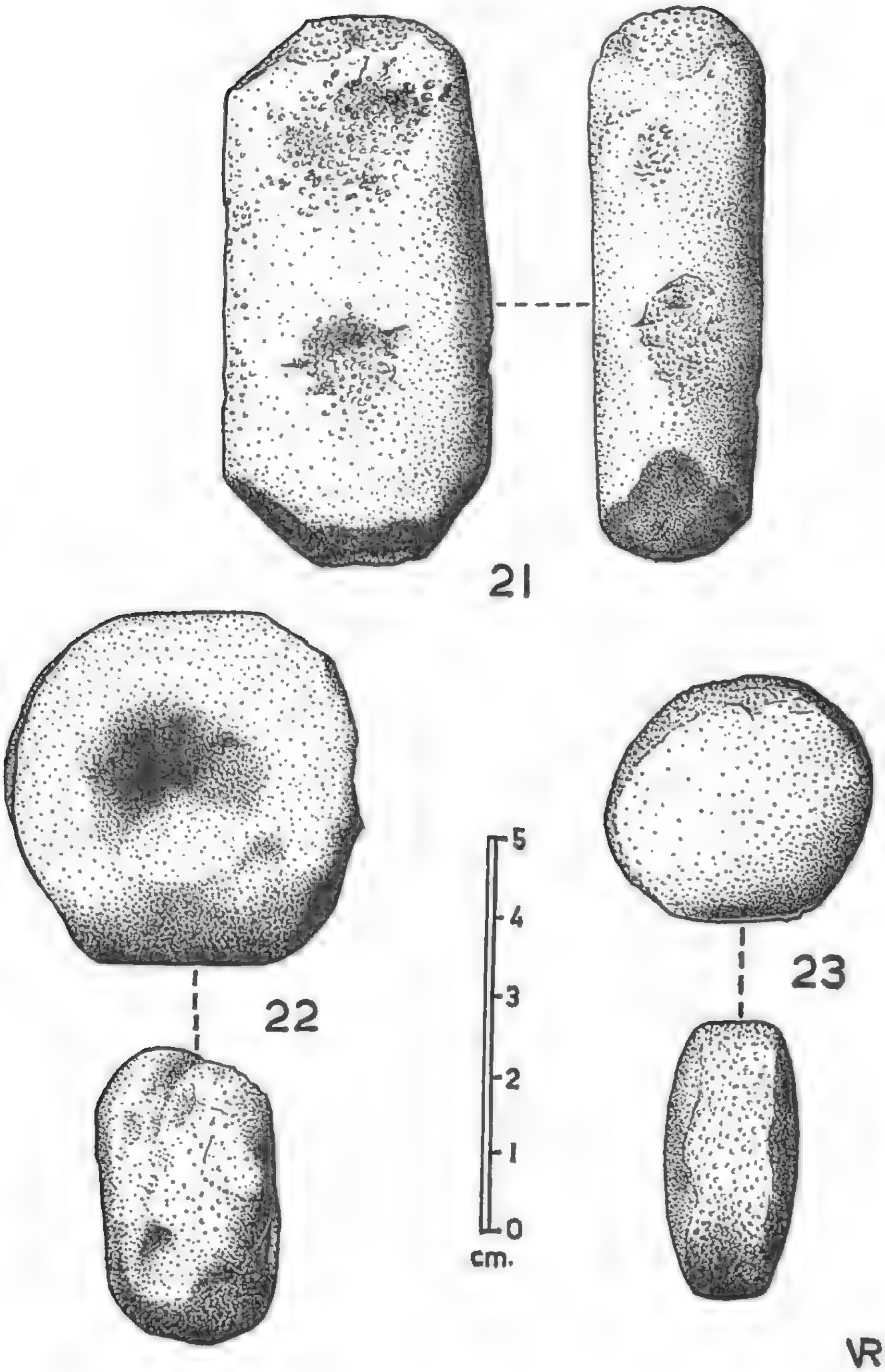
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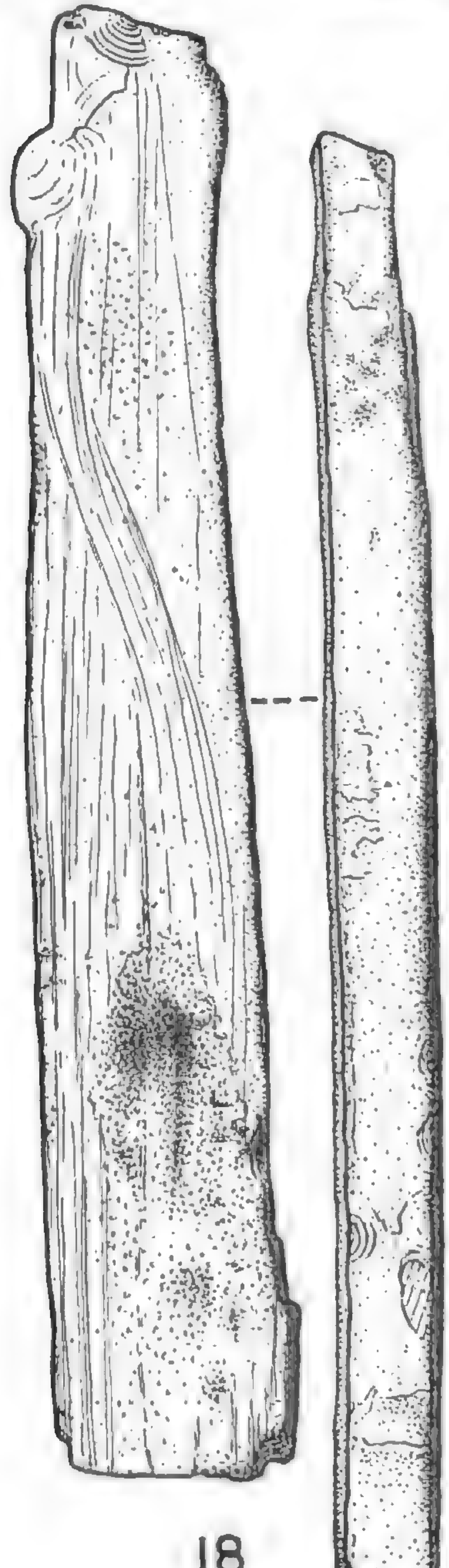

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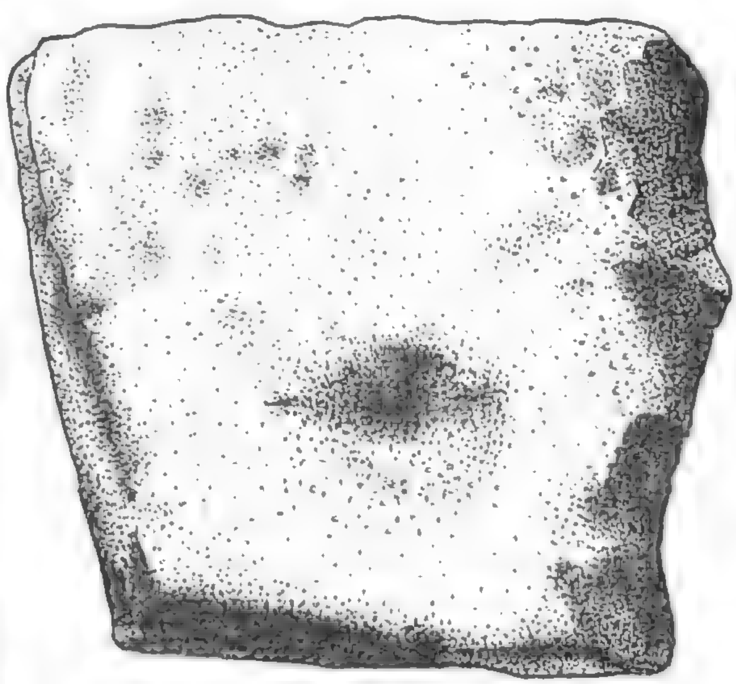

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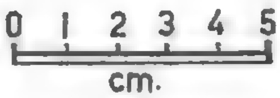

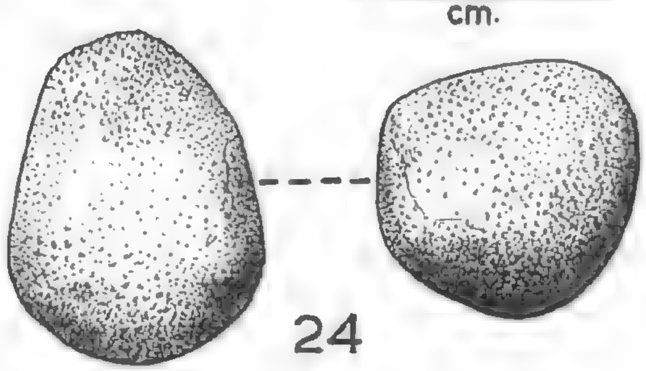

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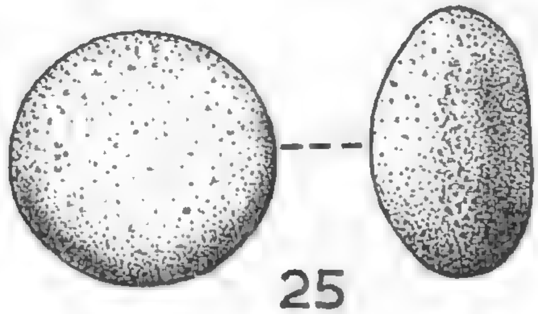

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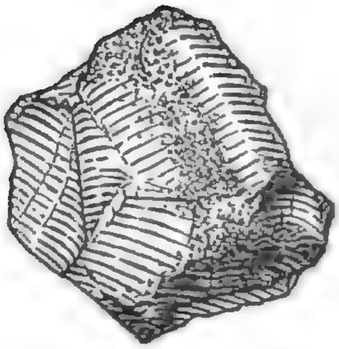

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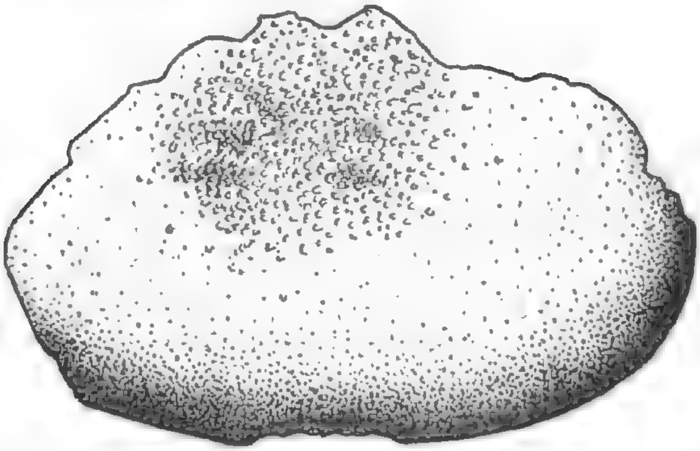

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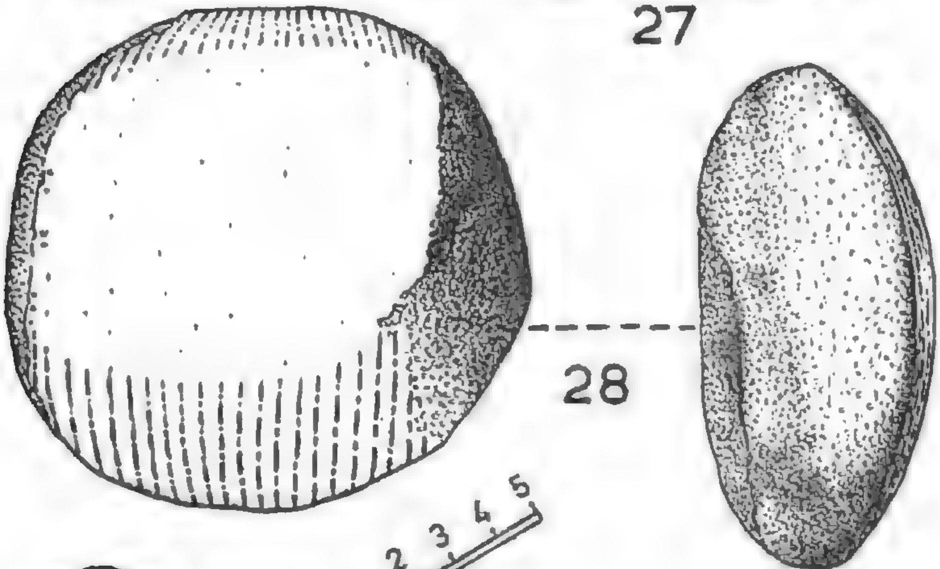

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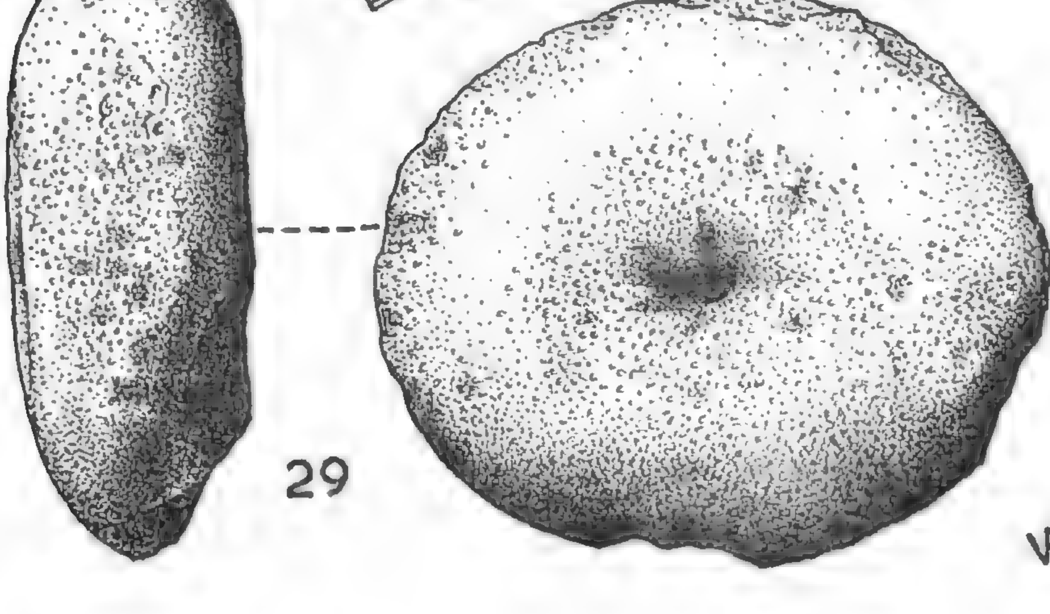

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LOCATIONS OF FIGURED SPECIMENS

Fig. 1. Sellick Beach.
Fig. 2. Port Rickaby.
Fig. 3. Pennington Bay, near. (Kangaroo Island.)
Fig. 4. Tiddy Widdy Well.
Fig. 5. Normanville.
Fig. 6. Hallett Cove.
Fig. 7. Murray Bridge.
Fig. 8. Cleve.
Fig. 9. Baan Hill.
Fig. 10. Brachina Creek.
Fig. 11. Brachina Creek.
Fig. 12. Normanville.
Fig. 13. Port Elliot.
Fig. 14. Normanville.
Fig. 15. Bulcara. (Kangaroo Island).
Fig. 16. Mundalla.
Fig. 17. Limestone Springs.
Fig. 18. Brachina Creek.
Fig. 19. Moorowie. (Mount Chambers Gorge.)
Fig. 20. Hog Bay River. (Kangaroo Island.)
Fig. 21. South Australia.
Fig. 22. Lake Albert.
Fig. 23. Loveday Bay.
Fig. 24. Bay of Shoals. (Kangaroo Island.)
Fig. 25. Bay of Shoals. (Kangaroo Island.)
Fig. 26. Moonta.
Fig. 27. Pennington Bay, near. (Kangaroo Island.)
Fig. 28. Pudalja.
Fig. 29. Bay of Shoals. (Kangaroo Island.)

The above drawings, acknowledged with appreciation, were executed by Miss V. Richardson, South Australian Museum. Dr. B. Daily, Curator of Fossils and Minerals in the same institution kindly identified the principal types of rocks selected by the natives for use as hammer-stones.

CENOZOIC STRATIGRAPHY AND VERTEBRATE PALEONTOLOGY OF THE TIRARI DESERT, SOUTH AUSTRALIA

BY R. A. STIRTON, R. H. TEDFORD, AND ALDEN H. MILLER

Summary

The origin and evolution of the Australasian vertebrate fauna has been the subject of considerable speculation due to the lack of evidence from the fossil record. The Pleistocene marsupials of Australia are fairly well known, but they tell us little about the Tertiary evolution of their ancestors. Only a few undoubted Tertiary marsupials had been reported prior to the investigations described in this paper. Baldwin Spencer (1900) described a bushytailed opossum from Fossil Bluff, Tasmania, which was critically reviewed and redescribed by Frederic Wood Jones (1930). This specimen was found in marine deposits containing foraminifera which are said to belong to the Janjukian "Stage" and probably Oligocene in age. Charles Anderson (1937) recorded diprotodontid and macropodid remains from New Guinea which are possibly late Pliocene or early Pleistocene. Edmund D. Gill (1957) and Stirton (1957b) have recently summarized the evidence on the few Tertiary marsupials found in Victoria. The Beaumaris fauna of Victoria is associated with late Miocene Cheltenhamian invertebrates, the macropodid from Forsyth's Bank belongs in the early Pliocene Kalimnan "Stage", and the cuscus from a podsol near Hamilton is referred to the late Pliocene (see review by Gill, 1957). Recently Martin F. Glaessner, B. McGowran, and M. Wade (1960) recorded part of the diaphysis of a "large kangaroo" femur from a place called Henty's near Hamilton, Victoria. This they consider as referable to the Balcombian "Stage" middle Miocene. Some other mammalian remains from Chinchilla in the Darling Downs of Queensland may be as old as Pliocene (Woods, 1956, p. 139; 1958, p. 189).

CENOZOIC STRATIGRAPHY AND VERTEBRATE PALEONTOLOGY OF THE TIRARI DESERT, SOUTH AUSTRALIA

By R. A. STIRTON, R. H. TEDFORD, AND ALDEN H. MILLER

Fig. 1-4

INTRODUCTION

The origin and evolution of the Australasian vertebrate fauna has been the subject of considerable speculation due to the lack of evidence from the fossil record. The Pleistocene marsupials of Australia are fairly well known, but they tell us little about the Tertiary evolution of their ancestors. Only a few undoubted Tertiary marsupials had been reported prior to the investigations described in this paper. Baldwin Spencer (1900) described a bushytailed opossum from Fossil Bluff, Tasmania, which was critically reviewed and redescribed by Frederic Wood Jones (1930). This specimen was found in marine deposits containing foraminifera which are said to belong to the Janjukian "Stage" and probably Oligocene in age. Charles Anderson (1937) recorded diprotodontid and macropodid remains from New Guinea which are possibly late Pliocene or early Pleistocene. Edmund D. Gill (1957) and Stirton (1957b) have recently summarized the evidence on the few Tertiary marsupials found in Victoria. The Beaumaris fauna of Victoria is associated with late Miocene Cheltenhamian invertebrates, the macropodid from Forsyth's Bank belongs in the early Pliocene Kalimnan "Stage", and the cuscus from a podsol near Hamilton is referred to the late Pliocene (see review by Gill, 1957). Recently Martin F. Glaessner, B. McGowran, and M. Wade (1960) recorded part of the diaphysis of a "large kangaroo" femur from a place called Henty's near Hamilton, Victoria. This they consider as referable to the Balcombian "Stage" middle Miocene. Some other mammalian remains from Chinchilla in the Darling Downs of Queensland may be as old as Pliocene (Woods, 1956, p. 139; 1958, p. 189).

Stirton and Tedford came to South Australia on Fulbright Awards in 1953 to search for Tertiary mammalian faunas and if possible to initiate studies on the stratigraphic sequence of the assemblages. In his original invitation to us, the late Sir Douglas Mawson suggested the eastern side of Lake Eyre Basin as an area to explore. The expedition[1] organized that year was sponsored by the Department of Geology, University of Adelaide, the South Australian Museum, and the Museum of Paleontology of the University of California. It is interesting to note that after several months of most discouraging prospecting in the Lake Eyre Basin during which we went down Cooper Creek as far as the Malkuni waterhole (Emu Camp), G. Davidson Woodard made our first discovery of Tertiary mammals at Lake Palankarinna on July 27, 1953. This was the key that unlocked the door to the success of our subsequent expeditions. An account of the 1953 explorations appeared in Pacific Discovery (Vol. 7, No. 2, 1954), and preliminary descriptions of some of the late Tertiary Palankarinna mammals were reported by Stirton (1955).

When we left the field in 1953 we thought the Woodard locality would prove to be an extensive quarry. Unfortunately at that site the Mampuwordu channel sands in which the fossils occur had been truncated by the overlying Tirari Formation. Consequently the 1954 party soon depleted the quarry. Later that season outcrops of a correlative of the Katipiri Formation along the Warburton River were prospected from Cowarie to Kalamurina, and a locality was examined on the Diamantina near Birdsville. Finally four of us (Connell, Marcus, Stirton and Woodard) drove across southern Queensland to the Darling Downs, where we collected some fossils and measured sections near the Condamine River on the Nangram Lagoon and old Chinchilla Stations. Also exposures were prospected along King and Spring Creeks near Clifton and on Freestone Creek near Warwick. When the remainder of the party was returning to Adelaide, Lawson found part of a small mandible in the Etadunna Formation at Lake Palankarinna. This was subsequently described as the holotype of *Perikoala palankarinnica* Stirton (1957a). At that time we were still confused about the stratigraphic relations of the Mampuwordu Sands and the Etadunna Formation. Consequently *Perikoala* was incorrectly assigned to the Palankarinna Pliocene fauna.

The 1957 party made important contributions to our knowledge on the stratigraphy, found other productive fossil sites at Lake Palankarinna, and discovered fossils at Lake Kanunka and Lake

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(1) Personnel of the expeditions have been: 1953; Paul F. Lawson, Richard H. Tedford, G. Davidson Woodard, and R. A. Stirton. The party was later joined by Harold C. Reynolds. A side trip to Lake Menindee was made by Norman B. Tindale, Tedford, and Stirton. 1954; Wm. A. Cassidy, James K. Connell, Leslie F. Marcus, Lawson, Stirton, and Woodard. 1957; Harry J. Bowshall, Brian Daily, Lawson, and Tedford. 1958; Lawson, Stirton, and Tedford.

Pitikanta. By shovelling numerous trenches through the weathered surface materials across the exposures Daily and Tedford revealed the correct stratigraphic relations of the Etadunna Formation, the Mampuwordu Sands, and the Tirari Formation. This party also prospected along the Warburton River. For the first time now there was sufficient evidence to reveal the columnar positions of four vertebrate faunas.

In 1958 we collected extensively from the four faunas. The areas visited were Lake Ngapakaldi, Lake Kanunka, Lake Pitikanta, Lake Palankarinna, and from the Malkuni waterhole on down Cooper Creek to within 16 miles of Lake Eyre. In the course of refining and contributing to our information on the stratigraphy we discovered the late Pleistocene Katipiri channel sands with remains of *Diprotodon* at Lake Palankarinna.

All of our efforts to find fossil vertebrates in the underlying nonmarine Winton Formation thus far have failed. There is one piece of a large bone from Lake Howitt that may have come from that formation, but it is too incomplete and poorly preserved for identification.

Only preliminary identifications of the faunas are included in this report. Detailed descriptions of the higher vertebrates will appear in separate publications. The Ngapakaldi and Palankarinna mammals will be done by Stirton, the Kanunka and Malkuni mammals by Tedford, and the birds from all four faunas by Miller.

ACKNOWLEDGMENTS

This research and exploration for Cenozoic vertebrates and on the continental stratigraphy in South Australia is a joint project of the South Australian Museum and the Museum of Paleontology of the University of California. We are permanently indebted to the former Director, Mr. Herbert M. Hale, O.B.E. and all members of the South Australian Museum for their cordiality and constant assistance.

As the recipients of Fulbright Awards in 1953, Stirton and Tedford were sponsored by the Department of Geology of the University of Adelaide. We gratefully acknowledge their sponsorship and wish to express our appreciation to Professor Arthur R. Alderman and all members of his staff for their helpful suggestions and efforts to facilitate our work.

We are most appreciative of the support received through our Fulbright Awards and in particular to Mr. Geoffrey G. Rossiter (executive officer of the United States Educational Foundation in Australia) who did everything possible to make our experience in

Australia pleasant and profitable. The 1953 expedition was greatly facilitated by a liberal grant-in-aid by Dr. Malcolm C. McKenna. We are equally grateful to the National Science Foundation and to Dr. David D. Keck (programme director for Systematic Biology) for their generous support to continue in 1958. The 1957 expedition was financed by the South Australian Museum and by the Museum of Paleontology; also some of the funds for the other expeditions came from those institutions.

The encouragement and advice given by both the late Sir Douglas Mawson and Mr. C. Warren Bonython from the time we first thought of going to Australia has been of the highest order. Their confidence in our ability to attain our objective gave us the inspiration to surmount all discouraging obstacles. Much valuable information on the geology of South Australia was received from Drs. F. W. Whitehouse, R. C. Sprigg and M. F. Glaessner. We are especially indebted to Dr. Brian Daily for his assistance in working out the stratigraphy and for sketching from aerial photographs promising areas to explore. Mr. Norman B. Tindale, with his profound knowledge of geography and aboriginal place names, has generously placed all of this information at our disposal.

All success of our efforts in the exploration must be attributed to the team work of all members of the field parties. The efforts of Mr. Paul F. Lawson however deserve especial recognition. He has assumed all the difficult tasks of organizing and procuring the materials necessary for all operations in the field. Furthermore he has found most of the best specimens which will be designated as holotypes. His assistance and suggestions both in the field and in the laboratory have been invaluable.

Australian hospitality was well exemplified at the Etadunna Station where we were made welcome by Mr. and Mrs. E. J. Oldfield. There we stored our provisions and came at regular intervals for fresh water. It is not possible to list here all of our other friends in Australia who were equally generous and hospitable to us, but to all we are most grateful.

GEOCHRONOLOGIC, STRATIGRAPHIC AND FAUNAL TERMINOLOGIES

Geochronologic Terminology.—Our most difficult problem in the Tirari area is to determine the age of the rock units in which the fossils occur. Except for the upper part of the Katipiri Formation with the remains of *Diprotodon*, our reference to the Lyellian time terms is little more than a guess. Unfortunately we have discovered no volcanic rocks to offer means of absolute dating with radioactive materials. Nor does the age of the marine formations in Victoria and Tasmania in which land mammals have been found help us at this time. Mammalian remains are meagre and very incomplete in these formations, nor is there any indication of closely related forms occurring in the marine beds and in the Tirari area, although additional specimens from these or from other formations may offer important clues. If fossil pollen occurs in these rocks it may be useful in correlation. This will necessitate a research programme in palynology but this is beyond the scope of our present project.

Our suggestion of Lyellian time terms is based on our interpretation of the stage of evolution of the mammals. This of course is largely speculative because we have no phyletic control even in the Macropodidae which are better represented in the fossil record than any of the families of Australian mammals. If we assume that the rate of evolution in the hypsobrachyodont Macropodinae is roughly comparable to that of the brachyhypsodont to hypsodont Equinae, then we may reasonably conclude that the Etadunna formation is as old as Oligocene. This will be discussed further when the faunas are described in detail in our forthcoming reports. When knowledge on the vertebrate paleontology and continental stratigraphy of Australia offers adequate information for correlation, it will be interesting to see how far off we were in our first tentative Epoch designations.

Our rock sequences are not complete enough to represent a continuous succession of chronostratigraphic units, even from the different exposed sections. Until the succession of the Tertiary vertebrate faunas is much better known, or other evidence is available, we shall have no means of knowing the duration of the hiatuses represented by the unconformaties and disconformaties between our formations. The faunas, however, indicate that the longest is between the Etadunna and the Mampuwordu.

Stratigraphic Terminology.—We have proposed four formational names. The *Etadunna, Mampuwordu, Tirari* and *Katipiri*. Each of these formations is distinguished on its lithologic character and on the basis of its stratigraphic position in relation to the other formations. They are not defined on the basis of their contained fauna or faunas. The maximum horizontal or vertical extent of these units is not observable and therefore not determinable from the surface exposures. The lacustrine Etadunna Formation is evidently the most extensive and our knowledge of the Mampuwordu channel and flood

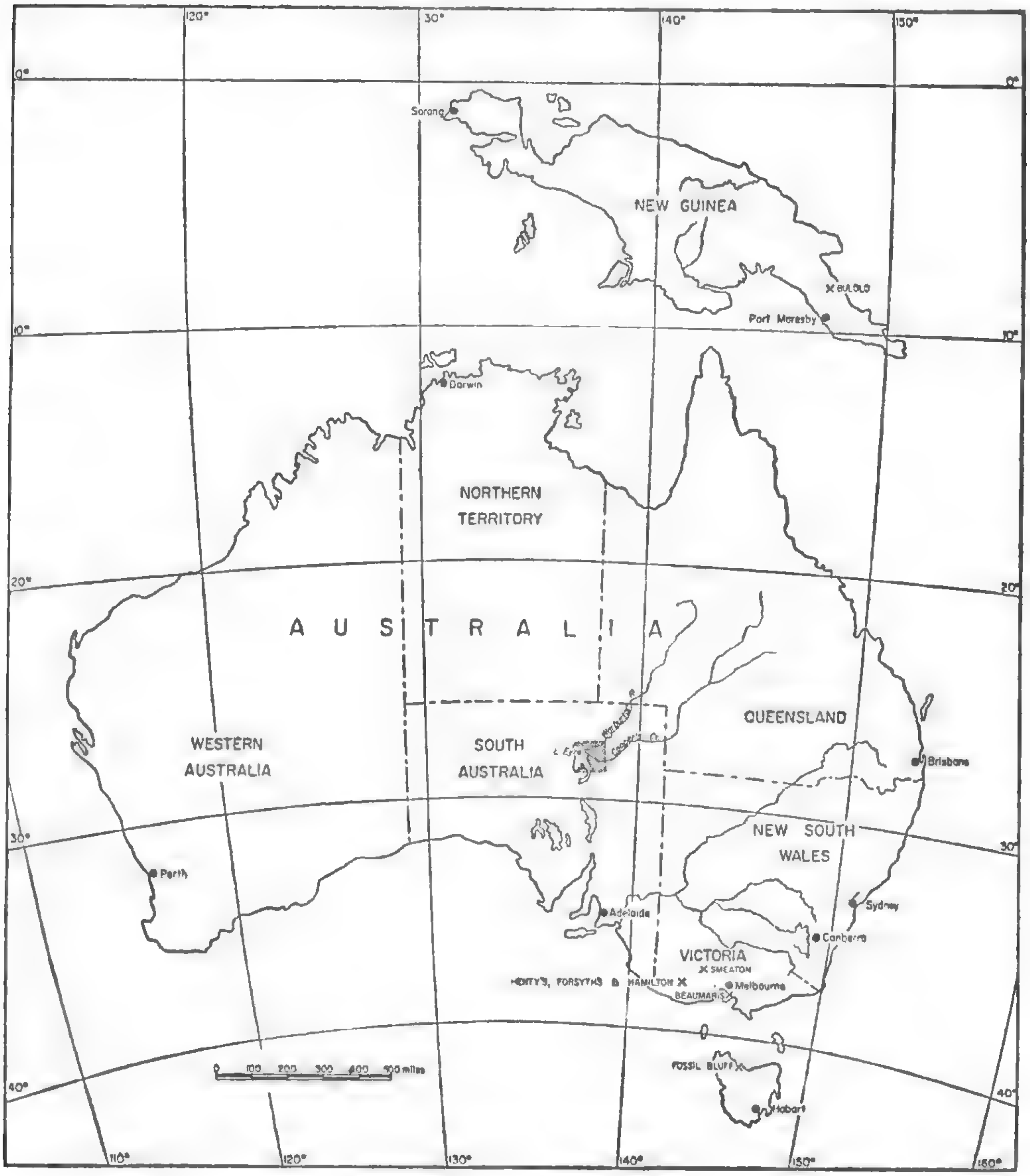

Fig. 1. A map of the Australasian region showing the location of the Tirari Desert area east of Lake Eyre. The other Tertiary and early Pleistocene faunal localities are indicated by X (see correlation chart, fig. 3).

plain sands is limited to a local area at Lake Palankarinna. The red argillaceous sandstones and arenaceous claystones of the Tirari Formation are also wide spread, possibly almost as much so as the Etadunna. The Katipiri fluviatile beds possibly represent all of Pleistocene time. They are exposed at Lake Palankarinna, Lake Kanunka, Lake Pitikanta, Lake Ngapakaldi, along Cooper Creek, and probably farther north.

Faunal Terminology.—Most vertebrate paleontologists, especially those working with fossil mammals, consider their fossil assemblages as biological entities and refer to them as faunas (or local faunas). This procedure has been employed to implement efforts in the application of the biologic evidence to the problems of faunal succession, paleoecology, and geochronology. The term "fauna" as used here (Stirton, 1936, 1940) need not be confused with the concept of fauna as representing all the animals living in a given area at a given time. In fact there is no local area of any appreciable extent in which we can know, or hope to know, all of the animals that lived, or are living, at any given time. In any event the evidence available to us can be considered only as a representation of that fauna.

An assemblage of fossils from one locality may represent the mammals living in a given area at a given time. Several assemblages from different sites may be recognized as belonging to one fauna. A single species or an individual fossil specimen may be our sole representation of a distinct faunal unit and may be so designated. Collections of fossils from different localities are recognized as representing a fauna when the genera and species are the same. Separate faunal names may be employed when the paleontologist has reason to assume that the materials before him represent distinct faunal units, even though the specimens cannot be precisely identified to genus and species. Eventually additional evidence may necessitate synonymizing certain faunal names; on the other hand a faunal name as it has been applied to certain fossil materials may be found to refer to two or more faunas. This need not be considered as confusing nor misleading but as normal procedure as our knowledge increases.

This biologic approach offers basic control units in phylogenetic, paleoecologic and stratigraphic interpretations. Many fossil mammalian assemblages occur in fluviatile deposits where there is no chance of tracing the beds laterally and where there is little or no chance of establishing suprapositional or infrapositional temporal control with other rock units in the section. In other areas the stratigraphic position of the sites where fossils are found may be obscured by complex geologic structure. Therefore it is only exceptional when mammalian fossils are sufficiently represented in a continuous succession of chronostratigraphic units to permit the delineation of Stages and Zones (Savage, 1955). One fauna may be distributed throughout a considerable thickness of rocks because of relatively rapid deposition of sediments. On the other hand due to a slow accumulation of detritus, or alterations in the distribution of animals, two or more distinct faunas may occur very close to one another in a vertical section. Locally or within an area of 50 miles, marshland, woodland and grassland environments may affect the composition of synchronous faunas. Some animals with wide environmental tolerances will frequently reveal the contemporaneity of such faunas. These synchronous assemblages of different composition (faunal facies) when discovered as fossils may be recorded by distinct faunal names.

We have recognized four faunas in the area here referred to as the Tirari Desert. A type locality has been designated for each of these faunas as is standard practice in introducing new formation names. To avoid confusion these have been given local geographic names that differ from the names of the formations. The reason for this is apparent because we have recognized two faunas, the *Malkuni* and the *Kanunka*, as coming from the Katipiri Formation. The *Malkuni* fauna is represented from numerous localities along Cooper Creek and at Lake Palankarinna. On the other hand we have found the *Kanunka* fauna in remarkably similar channel sands only at Lake Kanunka. Eventually one of our faunas may be discovered elsewhere in Australia in a different formation. The *Palankarinna* fauna is thus far restricted to two localities at Lake Palankarinna in the Mampuwordu Sands. Remains representing the *Ngapakaldi* fauna are more widely distributed. There are numerous localities at Lake Palankarinna, one at Lake Kanunka, and several at both Lake Pitikanta and at Lake Ngapakaldi.

STRATIGRAPHY AND VERTEBRATE PALEONTOLOGY

The term Tirari Desert was first used without explicit definition by John Walter Gregory (1906) for the sandridge country between the Warburton River and Cooper Creek occupied by the Tirari aboriginal tribe. As used in this report the Tirari Desert actually represents a southern extension of the Arunta (or Simpson) Desert east of Lake Eyre, bounded to the east by a north trending anticlinal axis involving Mesozoic and early Tertiary rocks. The southern boundary is the divide between the Lake Eyre and Lake Frome basins formed by a north-easterly trending anticlinal axis involving Mesozoic and Tertiary rocks. North of the Warburton River the Tirari Desert merges with the southern Arunta Desert.

The present-day physiography of this region is dominated by a remarkably linear system of parallel sandridges, the long axes of which trend slightly west of north (Madigan, 1946). Characteristic of the Tirari Desert is the great number of large and small saltpans, basins of very local drainage, produced by large scale deflation in late Quaternary and Recent time. Donald King (1960) has given an extended discussion of the sandridge deserts of South Australia. Cutting across the sandridges and in places into the underlying formations are two large stream courses, Cooper Creek and the Warburton River, that carry flood waters from eastern Queensland into Lake Eyre North.

The stratigraphy of the area covered during these investigations has never received detailed attention although the general geology of the Lake Eyre Basin as a whole is fairly well known (see Sprigg (1958) for summary).

G. L. Debney (1881a) gave the only account of the pre-sandridge geology of the Tirari Desert in a report on the results of attempts to locate shallow wells in this country during the latter part of the last century. Significantly he mentions (p. 146) "the broken face of the escarpment of the table hills, overlooking a salt lake 25 miles north-west of Lake Killalpaninna, displays marly clays mixed with gypsum and fossil bones. The fossils, which have been determined by Professor Tate, consist of fish vertebrae, teeth and the bony scales of crocodiles, and phalanges of a gigantic marsupial of the family of kangaroo, from which it may be safely concluded that the marly clays, sandstone, and gypsiferous beds of the tableland country are of lacustrine origin". This discovery was mentioned by Ralph Tate (1885, p. 54) whose list includes "phalanges of an emu-like bird" instead of those of a kangaroo. In any event it appears that Debney discovered Lake Kanunka where bones of the Kanunka vertebrates had weathered out of the loose channel sands of the Katipiri Formation and occur as float on the Etadunna exposures below. It appears from Debney's (1881b) well logs at sites 1-4 that the Katipiri channel and flood plain sands were well distributed out from the present course of Cooper Creek. Only at his well site 2 which is 4½ miles north of Cooper Creek and 23 miles east of Lake Eyre did he find a section like the ones we have described at Lake Kanunka and Lake Palankarinna. Evidently that bore cut through the Katipiri and Tirari formations and some six feet into the Etadunna.

John W. Gregory (1906) and Cecil Thomas Madigan (1945) crossed the Tirari Desert, but give only a cursory discussion of the sandridges and saltpans. Gregory's primary interest was in the fossil vertebrates reported from Cooper Creek and the Warburton River. In so far as we can determine at this time, all the fossils collected in the Tirari Desert area by the Gregory expedition belong to the Malkuni fauna. He apparently was not aware of Debney's discovery in the sandridge country between these rivers. Recently D. King (1956 and 1960) has dealt with the late Cenozoic deposits exposed in the southwestern margin of the Tirari Desert along the southern shores of Lake Eyre, but this is 50 to 60 miles southwest of the area discussed in this report.

Exposures of middle and later Cenozoic rocks in the Tirari Desert are widely scattered due to the ubiquitous sandridge cover which obscures most of the underlying deposits. Only here and there where deflation or the major water courses have carved deep enough into the desert floor are exposures to be found. Therefore the margins of the numerous saltpans (usually the western sides) and banks of the entrenched Cooper Creek and Warburton River expose the only significant outcrops of pre-sandridge rocks in the Tirari Desert.

It was found that the distinctive lithologies and superpositional relationships of the formational units could be recognized over wide areas, even though the outcrops are discontinuous. In some instances it has been possible to check these lithological correlations with fossils.

Three general localities are dealt with somewhat in detail in this report (Fig. 2). They were singled out because they have yielded the most significant fossil vertebrate remains and offered the best exposures of the formations. The type sections of our stratigraphic units and the type localities for the faunas have been designated from these local areas.

1. *Lake Palankarinna.*—This is the best single section so far discovered. Late Mesozoic and middle to later Cenozoic rocks are continuously exposed in a dissected escarpment stretching for about three miles along the western side of this saltpan. Lake Palankarinna is south of Cooper Creek and about 18 miles southwest of Etadunna Station at approximately latitude 28° 47′ S., longitude 138° 25′ E.

2. *Lake Kanunka, Lake Pitikanta and Lake Ngapakaldi.*—Nearly 30 miles north of Lake Palankarinna are exposures along the shores

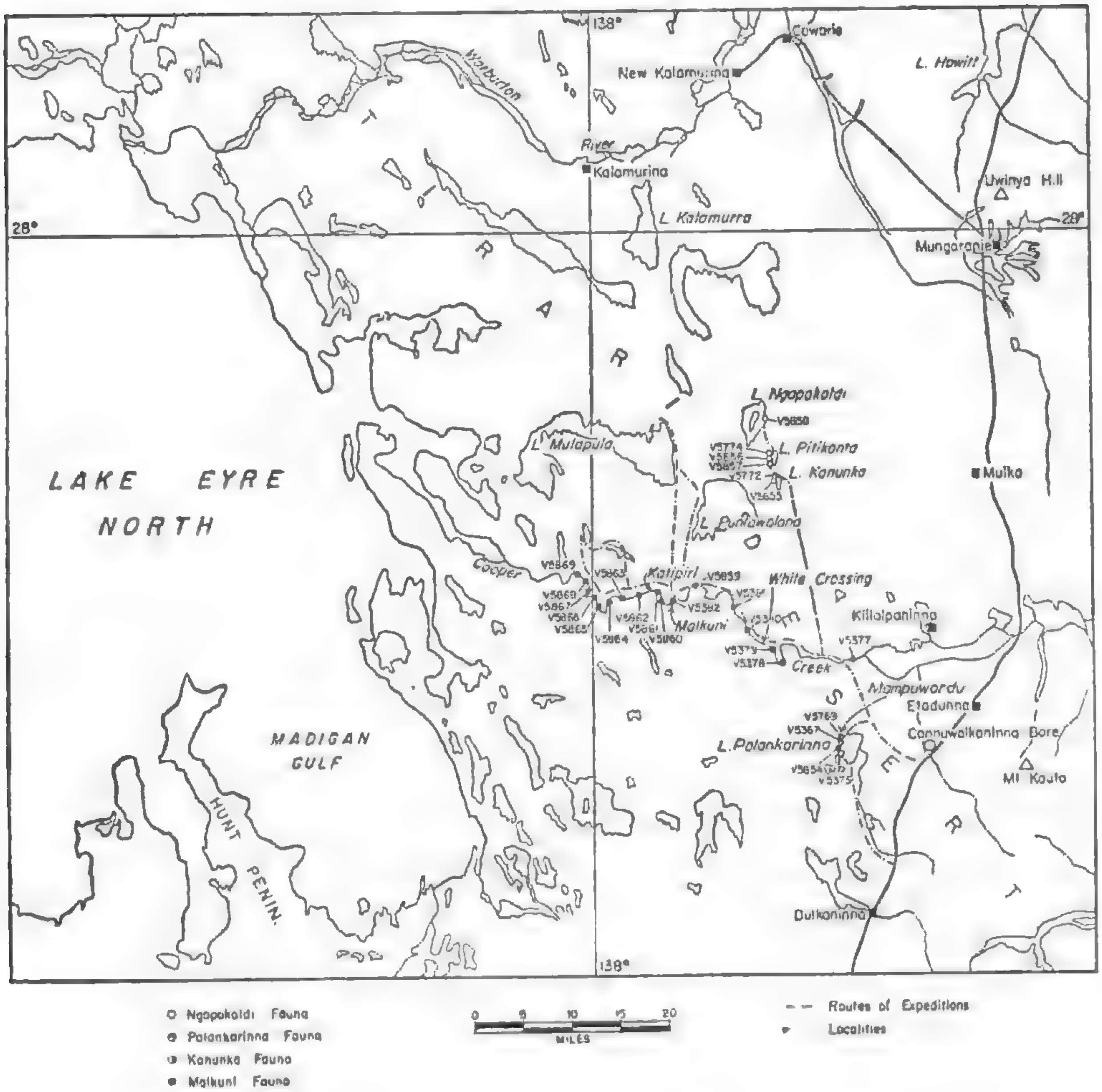

Fig. 2. The Tirari Desert area east of Lake Eyre, South Australia. There are many more Ngapakaldi faunal localities on the west side of Lake Palankarinna than indicated on this map.

of the two small lakes, Lake Kanunka and Lake Pitikanta, and Lake Ngapakaldi. There we have found important fossil vertebrate remains, especially those from the lower channel sands of the Katipiri Formation and from the much older Etadunna Formation.

Lake Kanunka and Lake Pitikanta are small saltpans only 1½ miles long and two miles apart in the same interdune valley at approximately latitude 28° 23′ S., longitude 138° 18′ E.

Three miles north of Lake Pitikanta lies the larger Lake Ngapakaldi at approximately latitude 28° 18′ S., longitude 138° 15′ E. Only the exposures of the Etadunna Formation on the eastern side of this saltpan have yielded fossils of the Ngapakaldi fauna. The same fauna occurs in outcrops of the same formation on the west sides of Lake Kanunka and Lake Pitikanta.

3. *Katipiri waterhole, Cooper Creek.*—There is an excellent cliff exposure along the northern bank of Cooper Creek at Katipiri waterhole, 24 miles northwest of Lake Palankarinna at approximately latitude 28° 35′ S., longitude 138° 6′ E. There the superpositional relationships of the upper fluviatile deposits of the Katipiri Formation are revealed.

On the following pages a composite stratigraphic column for the area investigated is described utilizing information drawn from a study of the three sections listed above. A description of the stratigraphic columns for each locality is given in Appendix A.

Late Mesozoic—Early Tertiary

The base of our oldest Cenozoic unit is exposed at the southwestern end of Lake Palankarinna. These basal green sandstones of

AGE	MEGAFOSSIL "STAGES"	MAMMALIAN FAUNAS	
		VICTORIA AND TASMANIA	LAKE EYRE BASIN
PLEISTOCENE			Malkuni f.
	WERRIKOOIAN	Smeaton f.	Kanunka f.
PLIOCENE	KALIMNAN	Hamilton f.[x] Forsyths Bank f.[x]	Palankarinna f.
MIOCENE	CHELTENHAMIAN	Beaumaris f.[x]	
	BALCOMBIAN		
	BAIRNSDALIAN		
	BATESFORDIAN		
OLIGOCENE	JANJUKIAN	Fossil Bluff f.[x]	Ngapakaldi f.
EOCENE			

x Directly correlated with the marine type sections or their generally accepted equivalents.

Fig. 3. Tentative correlation of some Cenozoic mammalian faunas.

the middle Tertiary Etadunna Formation rest unconformably on deeply weathered gray siltstones, clays and sandstones of the nonmarine Winton Formation, the uppermost Cretaceous unit recognized in the Lake Eyre Basin. Immediately south of Lake Palankarinna these older rocks are gently upwarped forming a low anticlinal divide separating the Lake Eyre and Lake Frome depressions. Superficial silicification (the formation of duricrust) of an extensive peneplane cut across the Cretaceous rocks and thin remnants of overlying early Cenozoic fluviatile deposits predates the deposition of the Etadunna Formation. The Etadunna Formation lacks any trace of large scale silicification and contains locally at its base a limonite cemented conglomerate of siliceous nodules derived from the Winton Formation. The absence of any marked southward coarsening of the Etadunna Formation against the duricrusted upwarp of older rocks suggests that this anticline was not a prominent feature in mid-Tertiary time.

Middle Tertiary (?Oligocene)

Etadunna Formation

Stratigraphy.—The term Etadunna Formation was first used by Stirton in his preliminary description of the mammals from the Palankarinna fauna (1955, p. 267). In that paper Stirton credits the term Etadunna Formation to G. Davidson Woodard who proposed it in a report on his pioneer investigations of Tirari Desert geology (unpublished manuscript on file at the Museum of Paleontology, University of California). It was assumed that Woodard's report would soon be published as planned. At that time the post-Winton lacustrine deposits at Lake Palankarinna and the immediately overlying channel sands with the Palankarinna fauna were thought to belong to the same cycle of deposition and hence to a single formation. Later stratigraphic work by Brian Daily and Tedford has shown that the channel sands are a distinct lithologic unit disconformably overlying the lake beds. As used here the term Etadunna Formation is restricted to the lacustrine deposits and a new name, Mampuwordu Sands, is proposed for the overlying channel sands containing the Palankarinna fauna.

At the type section, the bluffs along the western side of Lake Palankarinna, the Etadunna Formation consists of a maximum of 97 feet of green claystone and sandstone interbedded with white calcareous mudstone and dolomitic limestone (see Appendix A for detailed description). The basal green sandstone member of the

Etadunna Formation rests unconformably on the Winton Formation. A discontinuous basal conglomerate may occur at this contact. The basal member of the Etadunna Formation is succeeded by a sequence of dolomitic limestones, calcareous mudstones and claystones with several horizons of intraformational breccia denoting repeated exposure and drying of the shallow water lagoon in which these deposits formed. Poorly preserved gastropods, ostracodes and oögonia of *Chara* were found in the calcareous mudstones.

The succeeding strata at Lake Palankarinna consist of an alternation of green claystones and argillaceous sandstones yielding abundant, but fragmentary, remains of fish, reptiles, birds and some mammals (notably *Perikoala*). These deposits give way to a calcareous mudstone with interbedded claystone and calcareous sandstone. The uppermost units at the type section are fossiliferous arenaceous green claystones and interbedded sandstones in places overlain disconformably (probably with angular unconformity) by the Mampuwordu Sands. Where the Mampuwordu Sands are absent, the Etadunna Formation is overlain with angular unconformity by the Tirari Formation or locally by the succeeding Katipiri Sands.

At Lake Palankarinna the Etadunna Formation was folded into a broad syncline before the Mampuwordu Sands and horizontally bedded Tirari Formation were deposited. This folding may have corresponded with movements along the Mesozoic—early Tertiary anticlinal axis immediately to the southeast because the formations overlying the Etadunna are poorly sorted fluviatile deposits rich in fragments derived from a duricrusted terrain.

The Etadunna Formation exposed at Lake Kanunka, Lake Pitikanta, and Lake Ngapakaldi is thinner than at the type section but strikingly similar in lithology. There is a maximum of 24 feet of Lake Kanunka dolomitic calcareous mudstones with prominent intraformational breccias at the top which alternate with green claystones (for measured sections see Appendix A). Articulated mammalian skeletons and parts of skeletons were found consistently at the top of the lowest exposed green claystone and at the base of the immediately overlying calcareous mudstone. The positions assumed by the articulated skeletons of the abundant small diprotodonts and small macropodids suggest entrapment of the animals in boggy clay. Their remains are truncated and weathered where they projected into the overlying calcareous mudstone indicating exposure before burial beneath the overlying calcareous sediments. Although it is impossible directly to trace the fossiliferous horizon from Lake Kanunka and

Lake Pitikanta to Lake Ngapakaldi, the unusual concentration of mammalian remains at a similar stratigraphic position at each locality is tentatively accepted as indicating approximate synchronous deposition.

The Etadunna Formation at Lake Kanunka, Lake Pitikanta, and Lake Ngapakaldi is nearly flat-lying. There the strata are disconformably overlain by equivalents of the Tirari Formation and locally by the Katipiri Sands.

It is possible that the dolomitic mudstones and interbedded thin green clays recorded from the southern shore of Lake Eyre North by King (1956) are part of the Etadunna Formation. The unconformably overlying deposits at that locality cannot be correlated at present with any of the post-Etadunna Formations in the area we have studied.

Paleontology.—The vertebrate fauna from the Etadunna Formation is herein designated as the *Ngapakaldi fauna* with its type locality

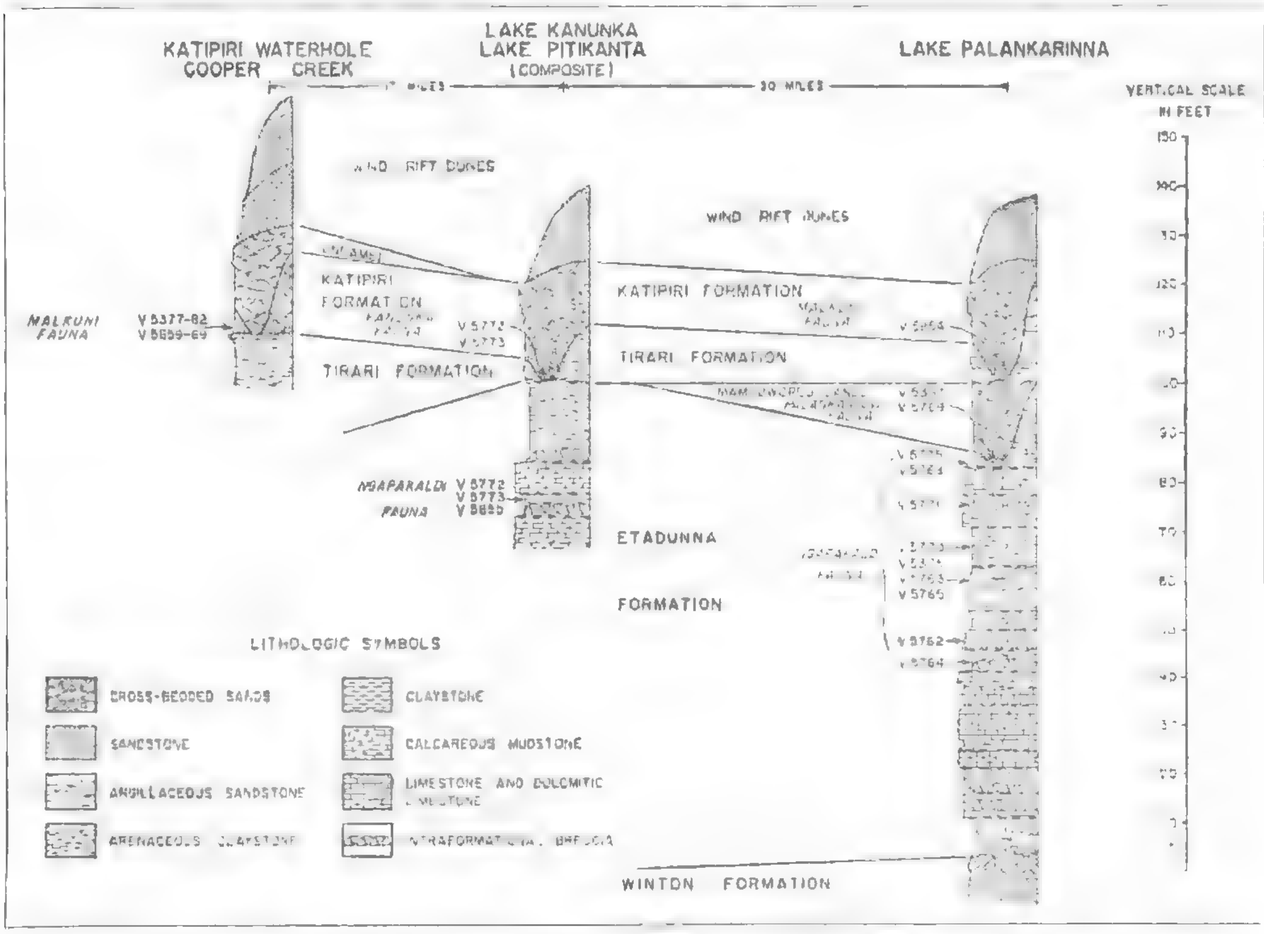

Fig. 4. Columnar sections indicating stratigraphic positions of faunas and formations in the Tirari Desert area east of Lake Eyre, South Australia. Scale in feet.

on the east shore of Lake Ngapakaldi (U.C. Loc. V 5858). Its most important representation is the locally abundant skeletal remains of marsupials collected on the eastern shore of Lake Ngapakaldi and the northwestern shore of Lake Pitikanta. Additional, but more fragmentary, marsupial material has been taken at the same horizon at Lake Kanunka and from members 4, 6 (*Perikoala*), and 9 of the Etadunna Formation at Lake Palankarinna.

A provisional faunal list for the Ngapakaldi fauna is given below combining the material from all the localities mentioned. Only the koala-like *Perikoala* has been previously described (Stirton, 1957a).

NGAPAKALDI FAUNA (?OLIGOCENE)

Mollusca

Gastropoda: Poorly preserved gastropods have been found that evidently represent three genera.

Arthropoda

Ostracoda: Some fossil ostracodes occur in the calcareous mudstones but these have not been identified further.

Osteichthyes

Dipnoi:

Ceratodontidae: One locality at Lake Palankarinna yielded a large series of lungfish teeth. These for the most part are smaller than the teeth in the Malkuni and Kanunka faunas. Other teeth, however, found on the Etadunna exposures are as large as those in the later faunas.

Teleostei: Bones of teleost fishes are as abundant in the Etadunna Formation as they are in the later channel sands.

Reptilia

Chelonia: Parts of carapaces, plastrons, and body skeletal elements are abundant in this formation.

Crocodilia: Pieces of skulls and lower jaws were found at different sites, but these reptiles seemed to have been much less numerous than the turtles.

Squamata:

Varanidae: There is one vertebra of a large, but not gigantic, lizard.

Aves

More than 45 fragmentary bird bones represent a rather diversified avifauna. The collection is sufficient to permit identification to family as follows.

Pelecaniformes:

Pelecanidae: The distal end of a tarsometatarsus represents a pelican differing significantly from the modern genus.

Ciconiiformes:

Phoenicopteridae: The distal articulation of a tarsometatarsus represents the genus *Phoenicopterus* but the species is about 50 per cent larger than any modern flamingo. The family is not represented in the modern fauna of Australia.

Anseriformes:

Anatidae: A complete humerus is tentatively allocated to the subfamily comprising the spine-tailed ducks.

Gruiformes:

Gruidae: An imperfect proximal end of a tarsus is some form of crane.

Charadriiformes:

Burhinidae: A proximal half of a humerus apparently represents this family of shore-birds, the thick-knees.

Laridae: A distal half of a tarsometatarsus appears to represent a gull or a tern.

Mammalia

Marsupialia:

Dasyuridae: One of the most significant specimens found in the Etadunna Formation is a new genus of dasyurid. The size of the animal is comparable to *Dasyurus quoll*. This specimen consists of I^1; both upper canines, P^2, P^3, M^1 and M^2 of both sides; M^3; the left mandible with the canine, P_1, the anterior end of P_2, P_3 missing from its alveolus, M_{1-4} in place; part of a pelvis and much of the ulna, and numerous foot bones. The proximity of these parts in the claystone indicates they belong to a single individual. The three premolars with gradation in size from P_1 to P_3 and the absence of the metaconid on M_1 suggests that this animal may not be far removed from the ancestry of *Thylacinus*.

PHASCOLARCTIDAE:

Perikoala palankarinnica Stirton (1957a)

The type and paratype of this species were originally described as part of the Palankarinna fauna. We now know that they come from the underlying Etadunna Formation and belong to the Ngapakaldi fauna. As yet we have found no specimens referable to this species at Lake Kanunka, Lake Pitikanta, or Lake Ngapakaldi where most of the mammalian remains have been found.

MACROPODIDAE:

POTOROINAE: Part of a left mandible is referable to a group that is possibly ancestral to the genus *Bettongia*. Most of the horizontal and posterior parts of the jaw are missing. The incisor is broken off, but P_3, M_1, M_2 and M_3 are in place and little worn. The specimen is remarkably like the living bettongs especially in the premolar, but the details in the patterns of the molars are different.

Subfamily ?

One of the most remarkable mammals in the Ngapakaldi fauna is a new genus of questionable subfamily relationships. The skull is somewhat comparable in outline but more elongate than that of *Aepyprymnus*. On the whole however the new genus seems to be about equally distinct from each of the Recent potoroine genera as well as from *Hypsiprymnodon*. There are two crania with mandibles and parts of the body skeletons that belong to two individuals, as well as two other lower jaws with parts of the maxillaries associated, and parts of the lower jaws of still another individual. Features in the molars offer some suggestion of their derivation from a primitive marsupial with a tribosphenic pattern. Furthermore the transverse lophs and lophids are more trenchant and not as depressed in the middle as in the Potoroinae or the Hypsiprymnodontinae. The characters in these Ngapakaldi specimens are much like those seen in the living *Setonix brachyurus* as well as those in the three specimens discussed later in the Malkuni, Kanunka and Palankarinna faunas.

DIPROTODONTIDAE: The most abundant marsupial in the Ngapakaldi fauna is a primitive diprotodontid about the size of a domestic suid. Unfortunately the bones of the skeletons we have found thus far have been badly shattered by expansion and contraction in the surface weathering zone. Nevertheless enough specimens have been found to make a restoration possible, although adequately preserved cervical, thoracic and lumbar vertebrae, as well as bones of the sternum and ribs are still wanting. All of the bones in our collection have not yet been fully prepared and restored because of their fragmentary condition. The phylogenetic position of this interesting animal, as in most of the other Ngapakaldi marsupials, cannot be accurately determined until more of the genera and species intermediate between it and the later related genera can be found. The molars are sharply biliphodont with only slight indications of forelinks and midlinks. Of the premolars only $P\frac{4}{4}$ are present. They have a simple pattern and are reduced in size. The lower incisors are rather widely spatulate as in *Palorchestes,* not rounded as in the Diprotodontinae.

Late Tertiary (?early Pliocene)

Mampuwordu[2] Sands

Stratigraphy.—The Mampuwordu Sands are locally exposed stream channel deposits known only at the type locality, Lake Palankarinna. This formation contains the Palankarinna fauna partly described by Stirton (1955). Scattered remnants of probably widespread stream channel and floodplain deposits outcrop along the northwestern side of Lake Palankarinna where some have cut as much as 16 feet into the uppermost member of the Etadunna Formation. They are disconformably overlain by the Tirari Formation.

Mammalian remains have been found in local concentrations at the base of these channels at two localities in pebbly cross-bedded quartz sand and lenticular arenaceous claystones. These remains were commonly broken, but not badly waterworn. Broken fragments found separated in the fossil quarries were frequently found to fit together indicating no great distance of transport. Waterworn pebbles within the basal sands include duricrust and quartz fragments derived from the Mesozoic and early Tertiary deposits as well as limestone fragments derived from the underlying Etadunna Formation. The presence of fragments derived from the deeper parts of the Etadunna Formation suggest that the folding of these rocks preceded deposition of the Mampuwordu Sands. Regional uplift is reflected in the change from fine grained clastic and chemical sediments of the Etadunna to the coarser fluviatile deposits of the Mampuwordu Sands and the succeeding Tirari Formation.

Paleontology.—The Palankarinna fauna was taken from two quarries in the Mampuwordu Sands exposed along the northwestern

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(2) A Dieri name for a site at the northwestern end of Lake Palankarinna; approved by the State Nomenclature Committee of South Australia.

side of Lake Palankarinna. The Woodard Quarry (U.C.M.P. locality V 5367), the type locality, was discovered in 1953 and worked out in 1954. The Lawson and Daily Quarries (U.C.M.P. locality V 5769) are two bone-bearing pockets in a single channel discovered in 1957 about ½ mile north of the Woodard Quarry. Stirton (1955) gave a preliminary description of the 1953 collection from the Woodard Quarry. A provisional faunal list for both localities is given below.

PALANKARINNA FAUNA (?PLIOCENE)

Arthropoda

Crustacea:

Decapoda: Both gastroliths and pieces of the pinchers occur in this collection.

Osteichthyes

Teleostei: Numerous bones probably representing a diversified fish fauna have been taken from the Woodard locality.

Reptilia

Crocodilia: There are more than 125 isolated teeth, 7 dermal scutes and 6 parts of crocodilian skulls and mandibles. The ravages of these creatures may account in a large measure for the fragmentary condition of the mammal bones.

Aves

Casuariiformes:

Dromiceiidae: A tarsometatarsus seems clearly to represent a new species of this family. It is the first Tertiary record of the Dromiceiidae. The proportions of the bone are intermediate between those in the emu and the cassowary, but the species clearly was an emu and not a cassowary. A detailed study of this bone should contribute to our knowledge of the antiquity and evolution of these birds.

Mammalia

Marsupialia:

Peramelidae:

Ischnodon australis Stirton (1955)

The type and only known specimen is the anterior half of a right mandible with only the posterior half of the canine alveolus showing. P_{1-2} and M_{1-2} in place. P_3 is missing from the alveolus, and M_2 is broken across the talonid resulting in the loss of the posterolingual corner.

MACROPODIDAE:

?Subfamily: One left mandible with well worn teeth, although of about the same size as those of *P. palankarinnicus,* represents an *undescribed genus* of the Macropodidae. The construction of the molars, especially the less worn M_4, is much like that in the portion of a right mandible with M_3 and the anterior moiety of M_4 in the Malkuni fauna, which we have stated has Setonix-like molars. The Palankarinna specimen however is larger than the Malkuni species. When the species of this group are well exemplified, it may be thought advisable to recognize another subfamily.

MACROPODINAE:

Prionotemnus palankarinnicus Stirton (1955)

We have a large series of maxillae, mandibles, and limb and foot bones of this macropodid. Fossils of this macropodid are by far the most numerous of any vertebrate in the fauna.

A tibia with macropodine characters and of about the same length as those in *Prionotemnus* has a shaft nearly twice as great in diameter. This obviously belongs to another macropodid much larger than *Prionotemnus.*

STHENURINAE: There is a wide but short-crowned lower incisor that is suggestive of those seen in the Sthenurinae.

DIPROTODONTIDAE:

Meniscolophus mawsoni Stirton (1955)

Our information on this species has not been augmented since 1955.

Another diprotodontid (Stirton, 1955) is more like *Euowenia* than either *Meniscolophus* or *Nototherium.* More information on it must await the discovery of better specimens.

Late Tertiary (?Pliocene)

Tirari[3] Formation

Stratigraphy: Flat-lying brick red argillaceous sandstones and arenaceous claystones overly the Etadunna Formation at all three of the areas discussed in this report. Reconnaissance investigations indicate even more widespread occurrence of these deposits in the Tirari Desert.

(3) From the Tirari Desert in which these deposits are widespread.

The Tirari Formation is best exposed at its type section along the western shore of Lake Palankarinna where almost 40 feet of predominantly red, poorly sorted fluviatile deposits outcrop (see Appendix A). The lower third of the formation is dominantly arenaceous. Scattered pebbles of duricrust and milky quartz occur at the base, but no prominent basal conglomerate is developed. Current cross-bedding is common in these basal sands. The upper two-thirds is dominantly argillaceous.

At Lake Kanunka, Lake Pitikanta, and Lake Ngapakaldi the Tirari Formation does not exceed 13 feet and is dominantly a red arenaceous claystone with a few inches of coarser sand and duricrust pebbles at the base. Eleven feet of horizontally bedded red and mottled green and red arenaceous claystones outcrop at the base of the exposed section at the Katipiri waterhole on Cooper Creek. These deposits are also lithologically identified as the Tirari Formation. Only at Lake Palankarinna, Lake Kanunka, Lake Pitikanta and Lake Ngapakaldi can the Tirari Formation be seen unconformably overlying the Etadunna Formation.

The characteristic lithology and differences in the dominant grain size between these three areas suggest that the Tirari sediments may have been derived in large part by stripping of red soils developed on duricrusted pre-Etadunna rocks exposed to the south and east. The increasing dominance of argillaceous material toward the top of all sections may indicate the lowering of the source area and attainment of base level.

All attempts to find fossil material in the Tirari Formation have so far failed.

Pleistocene

Katipiri Sands

Stratigraphy.—Overlying the Tirari Formation at all three localities are stream channel and floodplain deposits which we have grouped together as a single formation, the Katipiri Sands. It is quite possible that some of these occurrences do not belong to the same cycle of deposition. We have evidence that they are not the same age everywhere yet at our present state of knowledge it is not possible to distinguish subunits on any consistent lithological grounds. Ultimately it may be possible to separate this complex of fluviatile deposits into two or more distinct units as future investigations reveal sections in which the superpositional relationships of units and their faunal assemblages can be established.

The Katipiri Sands rest disconformably on the Tirari Formation at the type locality, Katipiri waterhole on Cooper Creek, approximately 24 miles northwest of Lake Palankarinna. These stream channel deposits are dominantly arenaceous, consisting for the most part of conspicuously cross-bedded quartz sands. At the base these sands are poorly sorted, stained red, orange or yellow with limonite, and enclose duricrust, black chert and limestone pebbles, clayballs, ferruginous sandstone concretions, casts of small logs, and fragmentary vertebrate remains which are frequently abraded. Toward the top of the type section the sands are buff or white, better sorted, and finer grained. Gray arenaceous clay lenses and platy, spheroidal and pipey gypsum cemented sandstone concretions are common throughout (see Appendix A).

At the type locality the Katipiri Sands are overlain and deeply channelled by later fluviatile deposits described below. The Katipiri Sands contain the youngest fossil vertebrate fauna so far recognized in this part of the Lake Eyre Basin. This fauna includes the genus *Diprotodon.*

Post-Tirari Formation channel and floodplain deposits also occur at Lake Kanunka, Lake Pitikanta, Lake Ngapakaldi and Lake Palankarinna far from the present channel of Cooper Creek. At these localities they represent the youngest pre-sandridge formations, for they are directly overlain by the sandridge deposits.

The occurrence at Lake Kanunka is particularly significant, for fossil vertebrate materials taken from the Katipiri Sands at Lake Kanunka appear to represent an assemblage somewhat older than that from the type section. This is called the Kanunka fauna which apparently did not include *Diprotodon* although other smaller diprotodontids were present.

At Lake Kanunka these floodplain and stream channel deposits lie disconformably on the Tirari Formation. They vary from less than 10 to nearly 20 feet in thickness in the deeper channels where they have cut through the Tirari Formation to the top of the Etadunna Formation. In gross lithology they are identical with the type Katipiri Sands (see Appendix A).

At Lake Palankarinna up to 20 feet of floodplain and stream channel deposits rest disconformably on the Tirari Formation and in places cut through it to the top of the Etadunna Formation. In gross lithology these deposits are much like the type Katipiri Sands except for a somewhat greater prevalence of gray arenaceous clay lenses (see Appendix A). A lower jaw and part of the upper dentition of *Diprotodon* has been taken from these deposits suggesting that they may be about the same age as the Katipiri Sands at the type locality.

The sudden appearance of the Katipiri sandsheets in the Lake Eyre Basin may be the result of important uplifts in source areas probably within the margins of the basin in latest Cenozoic time. Larger clasts in the stream channel deposits were all derived from duricrusted Mesozoic and early Tertiary rocks or from the Etadunna and later formations.

Paleontology.—The oldest vertebrate fauna so far collected from the Katipiri Sands is known from a single locality at Lake Kanunka (U.C.M.P. locality V 5772). This may have been the locality discovered by Debney. Here the Katipiri stream channel has cut through the Tirari Formation to the top of the Etadunna Formation. The base of this deep (16ft.) channel has yielded generally fragmentary, but well preserved, bones and teeth and a few more complete jaws and limb-bones of vertebrates. This assemblage will be known as the *Kanunka fauna.*

KANUNKA FAUNA (?EARLY PLEISTOCENE)

Arthropoda

Crustacea: Decapoda: The fossils of crayfish are much more numerous at this locality than in the late Pleistocene Malkuni materials. There are 22 gastrolith nodules, 10 terminal parts of pinchers, and some associated elements of an exoskeleton.

Osteichthyes

Dipnoi:

Ceratodontidae: The lungfishes of the genus *Epiceratodus* are represented by 17 teeth. Superficially they look much like the ones from the Malkuni fauna described by White (1925).

Teleostei: Teleost bones are as plentiful and apparently represent a fish fauna as diversified as that of the Malkuni.

Reptilia

Chelonia: Parts of carpaces of a large chelonian and limb bones of a small form are indicative of at least two kinds in this fauna.

Squamata:

Varanidae: One tooth somewhat ovate in cross-section and with serrate edges like those in the giant megalanid seems clearly referable to this family.

CROCODILIA: Seventy-two teeth, 5 vertebrae, a dermal scute, and parts of two mandibles have been collected. The teeth range in size from very large to very small. At least we can say that crocodilians were as abundant in the Kanunka fauna as in the Malkuni.

AVES

It is estimated that a total of eight species will be recognized among the 48 specimens now at hand from this fauna when adequate Recent skeletons are available for comparison. Those tentatively identified are:

CASUARIIFORMES:

DROMORNITHIDAE: There are four parts of bones from a large dromornithous bird that appear to belong to the genus *Genyornis* but are smaller than the late Pleistocene *G. newtoni.*

PELECANIFORMES:

PHALACROCORACIDAE: There are two species of the genus *Phalacrocorax* (cormorants). These bones are small and medium-sized and as such are the counterparts of two of the species in the modern fauna, but they may prove to be specifically distinct. About one-sixth of the bird bones in the Kanunka fauna belong to cormorants.

ANSERIFORMES:

ANATIDAE: One bone of the genus *Anas* (duck) is comparable in size to the American shoveler. Four other specimens belong to *Cygnus* (swan). It will require more detailed comparisons than those possible to make now to evaluate the specific affinities of these fossils.

MAMMALIA

RODENTIA:

MURIDAE: One upper incisor in this collection represents the oldest rodent thus far known from the Australasian Region.

MARSUPIALIA:

DASYURIDAE: There are parts of two individuals of a dasyurid that is larger than *Dasyurops* but smaller than *Thylacinus* or *Sarcophilus.* One specimen is a right maxilla showing alveoli of M^2 and M^3, and the paraconal-parastylar crest of M^4. The other is also part of a right maxilla displaying inner roots broken off and parts of the alveoli of the outer roots of M^2 and M^3, as well as parts of the alveoli for the roots of M^1. The paraconid-parastylid alveolar shear of M^4 (the only part of any of the teeth preserved) is narrow and shaped like that in *Dasyurops* and *Dasyurus*; it is not as thick as in *Thylacinus* or *Sarcophilus* nor is it shaped like them. The animal appears also to have been smaller than *Glaucodon ballaratensis* Stirton (1957b). It seems then to have been a large dasyurid most closely related to *Dasyurus* and *Dasyurops*.

THYLACOLEONIDAE: The oldest known fossil referable to this family is a M^1 in the Kanunka fauna. It probably belongs to the genus *Thylacoleo*, but a generic identification must await the discovery of more complete materials.

VOMBATIDAE: Two upper molars represent this family. One is apparently referable to the gigantic extinct genus *Phascolonus*. The other is much smaller and probably belongs to one of the Recent genera.

MACROPODIDAE:

POTOROINAE: The rat-kangaroos are represented by part of a right maxilla with M^{1-3} in place and by a nearly complete right mandible with the incisor broken off. These are clearly referable to the genus *Bettongia*.

?Subfamily: An upper P^3 and a M^3 appear to indicate a new genus. The M^3 is low crowned but not bunodont as in *Propleopus* nor like that in the Potoroinae. The pattern of the molar and the very much compressed anterior cingular shelf is much like that in *Setonix*, but the fossil belongs to an animal much larger than the quokka. Its size seems to be comparable to that of the larger wallabies. It appears to be closely related to part of a mandible in the Malkuni fauna, and possibly it falls in the same subfamily as a mandible in the Palankarinna fauna.

MACROPODINAE: Part of a right mandible with M_{1-2} in place and an M_3 erupting, and also an isolated upper molar are possibly referable to the genus *Lagorchestes*. The teeth are somewhat larger than in *L. conspicillatus*, but the pattern of the teeth is much like that of the Recent species.

Another genus and species is known from an excellent left mandible and several isolated cheek teeth. This animal was as large as *Protemnodon*. There are several outstanding diagnostic features in this material. It appears to be related to "*Sthenurus*" *minor* Owen (1877) and to "*Halmaturus*" *vinceus* De Vis (1895), but the Kanunka form is larger and differs in certain details in the teeth.

There is part of a left mandible in which P_2, DP_3, and M_1 have the crowns broken off, M_2 is well preserved, and M_3 is erupting. This is a wallabylike macropodid but the molars are wider in relation to their length than in *Wallabia*. It is comparable in size to the larger species of that genus. We have not been able to determine its relationships from this specimen.

Part of a lower jaw, four lower molars, one upper molar, a P^3, a lower incisor, and a IV metatarsal with composite phalanges, all may or may not belong to another species in this fauna. The animals appear to have been smaller than *Prionotemnus palankarinnicus* and certainly larger than the largest known *Wallabia*. The proportions of the molars are intermediate between *Prionotemnus* and *Wallabia*. The P^3 is more like that in *Prionotemnus* than *Wallabia* but the lingual longitudinal basin is larger and the intermediate ribs are not as prominent, and apparently there are two instead of three ribs as in *Prionotemnus*. On the other hand the construction of the proximal end of metatarsal IV resembles that in *Wallabia*. Perhaps more and better preserved specimens will clarify this problem.

An excellent left mandible and several isolated teeth are clearly referable to the genus *Protemnodon*. These specimens display several characters that distinguish them from the six types and referred specimens of the species from the Darling Downs and Wellington Caves proposed by Owen. Another *Protemnodon* lower molar in the Kanunka assemblage is much larger than those, from the same locality, mentioned above.

Two isolated upper molars with high lophs are in many ways suggestive of *Megaleia rufa*, but the Kanunka animal was considerably larger than the red kangaroo.

STHENURINAE: Part of a right maxilla with a well preserved M^2, the alveolus for M^1, and the posterior half of the alveolus for P^3 (which appears to have been wider than M^1 or M^2) evidently is related to *Sthenurus*. The posterolabial corner of a very young left P^3 and the unworn hypholophid of a right molar (possibly M^4) are also referred to this form.

Family Incertae sedis: There is one molar (M^4) that cannot be allocated to a family. It bears a marked resemblance to those in the small diprotodontids in the Ngapakaldi fauna although it is larger. The tooth differs from *Palorchestes* and agrees with the Ngapakaldi form in a minimum development of the midlink. The relationships of this form cannot be determined until more complete specimens are found.

DIPROTODONTIDAE: Conspicuous by its absence in this fauna is any specimen the size of *Diprotodon*. There is, however, an unworn left M^4 that displays characters like those in *Euowenia*. Two other molar fragments, a heavily worn I^1, three median phalanges and a distal phalanx, may also be referable to this form.

Fossil vertebrate remains were collected *in situ* in the Katipiri Sands at the type locality and farther down Cooper Creek, but the bulk of the collection was obtained on sandbars within the main channel of Cooper Creek where the fossil material had been transported during infrequent floods. As neither the subjacent Tirari Formation or superjacent fluviatile deposits are fossiliferous, it seems most likely that these redeposited specimens were washed out of the basal part of the Katipiri Sands which are exposed at or near the bed of the Cooper Creek channel in this area.

Fossil vertebrate remains from the bars of Cooper Creek were known to the Dieri, an aboriginal tribe inhabiting the area, who had legends to explain their origin (Gregory, 1906, pp. 3-4). One of the first collections from this area to reach scientific circles was made by Henry Yorke Lyell Brown as Government Geologist for South Australia during the later part of the last century. Some of Brown's original materials are now housed in the South Australian Museum, Adelaide. These discoveries were followed up in 1901-2 by J. W. Gregory who made an extensive collection from several localities along the lower course of Cooper Creek from the Malkuni waterhole westward for some 10 miles. Only the lungfish (White, 1925) and birds (De Vis, 1906) from this collection have been described. The mammalian remains were not described and their whereabouts are presently unknown.

All the material from lower Cooper Creek of undoubted or highly probable provenance in the Katipiri Sands is considered as the *Malkuni*[4] *fauna*. For the most part the material is fragmentary, consisting of broken limb-bones, isolated teeth and parts of jaws, but some more complete material is known. Such fossil remains have been secured by our party from the Unkumilka waterhole, 10 miles northwest of Lake Palankarinna, downstream to within 16 miles of Lake Eyre North. The best collections, however, came from near or below the Malkuni, Katipiri and Buljutu waterholes. The Malkuni fauna includes the following vertebrates:

(4) From a prominent waterhole on Cooper Creek 1 mile east of Katipiri waterhole. Valuable vertebrate material was obtained mostly as float but occasionally *in situ* from exposures of the Katipiri Sands in the bed and walls of the main channel of Cooper Creek immediately downstream from this waterhole. J. W. Gregory also collected at this locality (1906, pp. 80-81).

MALKUNI FAUNA (LATE PLEISTOCENE)

Arthropoda

Crustacea:

Decapoda: Part of a pinchers and three discoidal calcareous nodules sometimes called "gastroliths" or "crab's eyes" that are formed in the cardiac part of the stomach of crayfish have been found in this fauna.

Osteichthyes

Dipnoi:

Ceratodontidae: In 1925 Errol I. White described two species of lungfish of this fauna. The specimens were collected during the expedition of Professor John Walter Gregory for the University of Melbourne. These species, *Epiceratodus eyrensis* and *E. gregoryi*, are based on palatine teeth. The types are in the University of Glasgow collections, and paratypes are in the British Museum (Natural History). We have 11 additional specimens from Cooper Creek.

Teleostei: The isolated bones of teleosts are abundant. Evidently they represent numerous genera and species.

Reptilia

Chelonia: There are pieces of the carapaces, plastrons, and some limb bones.

Crocodilia: Numerous teeth, dermal scutes, and some skull parts demonstrate the presence of numerous crocodilians in these deposits. Some of these creatures were of enormous size.

Lacertilia: Parts of vertebra and a large claw are comparable in size to the remains that have been described from the Pleistocene of Australia as *Varanus* (*Megalania*) *priscus*. Charles Anderson (1930, p. 315) estimated this largest known lizard to be 15 to 17 feet long.

Aves

Bird bones are abundant in the Malkuni fauna. We have nearly 100 specimens. It is estimated that when the identification of herons, shorebirds and the remains of miscellaneous other groups have been completed, a bird fauna of at least 20 species will be recognized. Many species probably will be slightly or not at all distinguishable from the modern species but may reflect changes in distribution or ecologic conditions. Most of De Vis' (1906) three new genera and 17 new species described from the materials collected by the J. W. Gregory expedition of 1901 along Cooper Creek and the Warburton River will probably prove to be synonymous with modern species. Classification of these birds will require a careful statistical analysis utilizing series of the living species.

CASUARIIFORMES:

DROMORNITHIDAE: Ten bones of a large bird of the size of *Genyornis* have been recovered.

PELECANIFORMES:

PHALACROCORACIDAE: The genus *Phalacrocorax* (cormorants) is represented by birds of three sizes comparable to three modern species of South Australia. There are 19 bones of the large form, 26 bones of medium size, and four are small. The large cormorant has not been recognized in the Kanunka fauna and consequently may have appeared in this area since the early Pleistocene. These materials should afford an opportunity to derive information on alterations in the distribution of the five living species of Australasian cormorants and they may contribute to our knowledge of the ecology, fresh water versus marine, of these birds.

CICONIIFORMES:

THRESKIORNITHIDAE: A distal end of a tibiotarsus represents a spoonbill of the genus *Platalea*. At present we cannot indicate whether it is closest to *Platalea regia* or *Platalca* (*Platibis*) *flavipes* among the modern species because of lack of modern comparative material.

ANSERIFORMES:

ANATIDAE: Two species of large ducks (*Anas*) are known from two or three bones each. Another very small duck (*Anas*) may be a teal. Other specimens may belong to a goose, the genus of which has not yet been determined.

FALCONIFORMES:

ACCIPITRIDAE: A tarsometatarsus of an eagle of the genus *Uroaëtus* has been identified.

GRUIFORMES:

GRUIDAE: A carpometacarpus of a crane of the genus *Grus* is not surely identical with the modern *Grus rubicundus*. It may represent a smaller species.

STRIGIFORMES:

STRIGIDAE: An excellently preserved tarsometatarsus should throw some light on the history of the Australasian endemics of this small family that comprises the barn owls.

Mammalia

Rodentia:

Muridae: There are 4 maxillaries, 4 lower jaws, and one upper incisor of *Rattus* and one mandible, one maxillary, and one upper incisor apparently of *Notomys* from the Cannatalkaninna locality, all of which are fragmentary. None of the larger mammals so common in the Malkuni fauna farther down Cooper Creek was found in this locality. Consequently the fossils from this locality may be a somewhat later assemblage, although these murid genera have been found with the large extinct marsupials elsewhere; they have not yet been discovered in the Malkuni assemblages.

Marsupialia:

Dasyuridae: Several genera must have been present in this area at the time the Malkuni fauna was extant, but the only fossils recorded are a premaxillary fragment without teeth and a lower jaw both representing *Sarcophilus* sp. The latter is part of the Henry Yorke Lyell Brown collection in the South Australian Museum.

Phalangeridae: Of this large family only a right lower jaw of a bushy-tailed opossum, *Trichosurus*, is represented in the Malkuni fauna.

Vombatidae: There are 4 cheek teeth and a metapodial of the giant wombat *Phascolonus*.

Macropodidae: As in the Kanunka fauna, specimens of kangaroos are by far the most abundant fossils in the Malkuni collection. The numerous limb bones, foot bones and vertebra cannot as yet be accurately identified to genus. There are, however, some jaws, teeth, and limb and foot bones from which genera can be recognized.

Potoroinae: One left mandible with well worn teeth apparently is referable to *Bettongia lesueuri*. Other limb and foot bones may also belong to this species.

?Subfamily: This group of macropodids is represented by part of the right mandible of a medium-sized macropodid, with the protolophid of M_4, M_3 complete and part of the hypolophid of M_2. The teeth are low crowned but not bunodont nor are they like those in the Hypsiprymnodontinae or Potoroinae. The pattern of the molars and the much reduced anterior cingulum shelf is like that in *Setonix*. It is possible that this specimen belongs to the Kanunka fauna and was reworked from the older Katipiri channel deposits directly into Cooper Creek (see Kanunka faunal list). Of course it could have lived until late Pleistocene time.

Macropodinae: Several specimens representing different parts of the mandibles, teeth, and five or more fourth metatarsals are referable to *Protemnodon*. The best specimen, a left mandible, is in the size range of *Protemnodon og* Owen, and otherwise agrees with the late Pleistocene specimens from the Darling Downs and elsewhere. Five or more metatarsals also belong to *Protemnodon*.

A small species of ?*Wallabia* is represented by parts of two mandibles. One is a young specimen and the other is from an old animal with heavily worn teeth. One large lower molar belongs to *Macropus* cf. *ferragus*.

Sthenurinae: The genus *Sthenurus* is represented by five fragmentary mandibles and numerous limb bones. Two species seem to be present both of which are undescribed. They both appear to be more closely related to the long-jawed *S. atlas* than to the short-faced group represented by *S. occidentalis*. One is about the size of *S. atlas* but differs significantly in height of crown and morphology of the lower molars. The second species is a larger, long-jawed form with higher-crowned teeth. It is considerably larger than *S. atlas*, but otherwise it is similar in dental morphology. The lack of associated material makes it impossible to assign the limb bones to any of the species represented by dentitions.

Procoptodon is known from part of a maxilla with the teeth broken off. The species represented is apparently closely related to *P. goliah*. Several broken limb and foot bones also belong to this genus.

Diprotodontidae: Numerous teeth, part of one mandible, and limb and foot bones seem to be clearly referable to the genus *Diprotodon*. Both large and small animals are represented, although some of the smallest bones possibly belong to *Nototherium* or *Euowenia*, but this is not demonstrable with the comparative materials we have at hand.

Quaternary—Recent

Away from the present channel of Cooper Creek the Katipiri Sands are directly overlain by aeolian sands of the Tirari Desert sandridge system. King (1960) has recently attempted to show that these aeolian deposits are for the most part wind rift dunes, aeolian sandcapped erosional remnants flanking linear wind scoured channels cut into the latest Cenozoic fluviatile sandsheets. His suggestion, although limited to ground observations at the south end of Lake Eyre North, seems to be corroborated in the area under study because the local saltpans are clearly of deflation origin cut deeply into the

Cenozoic deposits. The present topography, as King believes, is probably of latest Quaternary or Recent age.

Post-Katipiri fluviatile deposits are found only along the present channel of Cooper Creek. At the Katipiri waterhole 17 feet of large scale cross-bedded gray to gray-brown argillaceous sands disconformably overly the Katipiri Sands in places, cutting through the latter to the top of the Tirari Formation (see Appendix A). These fluviatile deposits are also found at the Malkuni waterhole and they continue downstream beyond the Katipiri waterhole where they are consistently disconformably above the Katipiri Sands. They are unfossiliferous and were not studied in sufficient detail to warrant introduction of a stratigraphic name at this time. These deposits clearly predate the formation of the wind rift dunes for they are capped by the sand-ridge accumulations (see Katipiri waterhole section, Appendix A).

APPENDIX A

DESCRIPTIONS OF MEASURED STRATIGRAPHIC SECTIONS

A. Lake Palankarinna. In ascending order:

WINTON FORMATION

Gray argillaceous sandstone.—Poorly sorted, fine grained, subangular quartz sand in mottled purple-gray, buff and white argillaceous matrix. Abundant pipey and botryoidal limonite cemented and silica cemented sandstone concretions . . . . + 13ft.

ETADUNNA FORMATION (Type locality)

1. *Green argillaceous sandstone.*—Poorly sorted, fine grained, subangular quartz sand in light green argillaceous matrix, darker in colour toward top and bottom. Lenticular horizons of limonite stained sandstone. Local concentrations of siliceous nodules cemented with limonite at base, but no persistent basal conglomerate . . . . 8ft.

2. *Calcareous mudstone and dolomitic limestone.*—

(*a*) Calcareous mudstone.—Buff to white calcareous mudstone with scattered fine-grained, subangular quartz sand. Branching vesicular structures toward top. Limonite and manganous stain on joint surfaces and walls of vesicles . . . . 2ft.

(*b*) Gray arenaceous claystone.—Gray-green claystone with scattered fine-grained, subangular quartz sand. Base an intraformational breccia of subangular pebble-sized fragments of underlying calcareous mudstone . . . . 1ft.

(*c*) Calcareous mudstone.—White calcareous mudstone resting sharply on the underlying clay. Containing scattered fine-grained quartz sand . . . . 2ft.

(*d*) Gray arenaceous claystone.—Base intraformational breccia composed of pebble-sized subangular fragments of underlying calcareous mudstone . . . . 1ft.

(*e*) Calcareous mudstone and dolomitic limestone.—Limonite stained yellow to white calcareous mudstone with limestone nodules at base passing into massive limestone with chert nodules. Uppermost five feet alternating calcareous mudstone and thin dense limestone beds. Scattered fine-grained quartz throughout. Dendritic patch manganous stain and disseminated granules throughout. Calcareous mudstone at base and top with gastropods, ostracods and *Chara* . . 24ft.

3. *Green claystone.*—Pale green clay with scattered fine-grained quartz sand. Intraformational breccia at base composed of subangular to subrounded fragments of underlying calcareous mudstone in green clay matrix. Small branching vesicular structures abundant. Walls of vesicles coated with manganous granules and limonite. Passes transitionally at top into member 4 with increase in arenaceous component. Fossiliferous (U.C.M.P. locality V 5764) . . . . . . 2-5ft.

4. *Green sandstone.*—Pale green, well sorted, fine-grained quartz sand with lenses of green argillaceous sandstone. Fossiliferous (U.C.M.P. locality V 5762) . . . . 2-4ft.

5. *Green arenaceous claystone.*—Rests with marked contrast on member 4. Pale green claystone rich in fine-grained quartz sand. Branching vesicular structures as in member 3 with manganous granules lining cavities . . . . 2-4ft.

6. *Green argillaceous sandstone.*—Pale green, well sorted, fine-grained quartz sand. Individual grains subangular to subrounded. Green argillaceous lenses throughout, passing transitionally to member 7 with increase in dark gray argillaceous lenses at top. Fossiliferous (U.C.M.P. localities V 5375, V 5763, and V 5765) . . . . 9ft.

7. *Green claystone.*—Dark gray at base, gray-green at top with scattered fine grained quartz sand throughout. Fossiliferous (U.C.M.P. locality V 5770) . . . . 4-8ft.

8. *Calcareous mudstone.*—

(*a*) Calcareous mudstone.—White calcareous mudstone with scattered fine grained quartz sand. Small branching vesicles throughout. Manganous stain on vesicle walls and joint planes . . . . . . 2-3ft.

(*b*) Green arenaceous claystone.—Pale green claystone rich in subangular to subrounded, medium to fine-grained quartz sand .. 1ft.

(*c*) Calcareous sandstone.—White, well sorted, fine grained, subangular to subrounded quartz sand with 20-30% spherical or rod-shaped fine-grained fragments of limestone. Fossiliferous (U.C.M.P. locality V 5771) .... 0-1ft.

(*d*) Green claystone.—Pale green silty claystone with tiny branching vesicles. Walls of vesicles carry manganous stain ...... 0-1ft.

(*e*) Calcareous mudstone.—White calcareous silty mudstone with manganous dendrites, patch stain, and scattered small manganous nodules .... 1-6ft.

9. *Green arenaceous claystone.*—Base with gray-green claystone with scattered fine-grained quartz sand, passing into more arenaceous gray claystone with lenses of the fine-grained quartz sand. Upper 2ft. brighter gray-green highly arenaceous clay. Uppermost 6in. black arenaceous clay. Limonite stain and nodules, manganous stain and granules throughout. Fossiliferous at base (U.C.M.P. localities V 5755 and V 5778) .... 17ft.

Unconformity

Mampuwordu Sands (Type locality)

Channel sands.—Basal 1-6ft. white, cross-bedded, well-sorted, medium-grained, subangular to subrounded quartz sand with scattered pebbles (duricrust, limestone and milky quartz), green and black clay-balls and thin gray and green clay lenses. Upper part of unit more argillaceous, gray sandy shale with fine quartz sand lenses. Limonite stain throughout. Gypsum concretions occur in the sands and selenite along the joints and bedding planes. Fossiliferous at base (U.C.M.P. localities V 5367 and V 5769) .... 0-16ft.

Disconformity (probable angular unconformity)

Tirari Formation (Type locality)

Red argillaceous sandstone.—Basal few feet of mottled green and red or buff and red, cross-bedded, poorly sorted, medium to fine-grained quartz sand with scattered coarse quartz grains and pebbles of milky quartz, duricrust pebbles, and lenses of red or green arenaceous claystone. Quartz grains subangular to subrounded with larger grains appearing frosted. Locally 1ft. bed white to buff, cross-bedded, better sorted fine-grained, subangular to subrounded quartz sand 3-4ft. above base of formation. Six to 13ft. above base formation becomes more argillaceous; red arenaceous claystone with sandy lenses. Gypsum occurs throughout along bedding planes and fractures. Uppermost 5-10ft. intergrown with selenite along bedding planes, forming a massive caprock . . . . 0-38ft.

Disconformity (angular unconformity on Etadunna formation)

KATIPIRI SANDS

Base locally with 3-4 inch selenite sheet along contact with underlying rocks. Lower part of unit consists of lenses of yellow, cross-bedded; subangular to subrounded, coarse-grained, quartz sand with scattered gray clayballs; and duricrust pebbles interbedded with lenses of arenaceous gray clay. Several feet above base formation consists of cross-bedded, well sorted, medium-grained, quartz sand with gray clay lenses on cross-laminae. Increasing argillaceous component with gray arenaceous claystone at top. Upper few feet highly infiltrated with gypsum forming caprock.

Limonite stain common; gypsum abundant throughout; gypsum rosettes and sandstone concretions in lower part of formation. Most fossils near the base (U.C.M.P. locality V 5854) . . . . 0-20ft.

Disconformity

Wind rift dunes.

B. Lake Kanunka. In ascending order:

ETADUNNA FORMATION (base not exposed)

1. *Green claystone.*—Pale green claystone with scattered fine-grained quartz sand and silt; shows branching vesicular structures; darker green at top. Fossiliferous (U.C.M.P. locality V 5855) . . + 5ft.

2. *Calcareous mudstone.*—White dolomitic calcareous mudstone with pale green claystone fragments at base. Locally 1-2ft. thick silty horizon 1ft. above base otherwise arenaceous material scattered through argillaceous matrix. Manganous dendrites, granules and patch stain throughout . . . . 3-6ft.

3. *Green to gray arenaceous claystone.*—At base intraformational breccia of subangular white calcareous mudstone fragments in dark gray argillaceous matrix. Calcareous fragments smaller and better rounded above passing to uniformly gray claystone rich in fine grained quartz sand and silt 2ft. from base. Three feet from base gray-green arenaceous claystone with waterworn fish and reptile remains. Member becomes yellow green at top with limonite stain . . . . 6-16ft.

Disconformity

TIRARI FORMATION

Red arenaceous claystone.—Red claystone with abundant poorly sorted, subangular to subrounded, fine to medium-grained quartz sand interbedded with lenses of purer red claystone. Uppermost 4ft. mottled red and green sandy claystone . . . . 0-12ft.

Disconformity

KATIPIRI SANDS

Channel and floodplain sands.—Lower portion of formation limonite stained, cross-bedded, coarse and medium-grained quartz sand with pebbles of duricrust and limestone; abundant green and red clay balls, clay plates showing remnant polygonal outline, argillaceous lenses, coprolites, and abraded remains of fish, reptiles, birds and mammals. Four to five feet above base the quartz sands are white, better sorted, medium to fine-grained and with red argillaceous lenses and occasional vertebrate remains. Gypsum cemented spheroidal and pipey sandstone concretions occur throughout. Base of channel above contact with Etadunna Formation locally cemented with selenite. Fossiliferous (U.C.M.P. localities V 5772 and V 5773) . . . . . . 6-16ft.

Disconformity

Wind rift dunes.

C. Lake Pitikanta. In ascending order:

ETADUNNA FORMATION (base not exposed)

1. *Calcareous mudstone.*—White dolomitic calcareous mudstone with scattered fine-grained quartz sand and silt, manganous stain and granules . . . . + 6ft.

2. *Green claystone.*—Intraformational breccia at base, subangular pebbles of underlying calcareous mudstone in green claystone matrix. Lighter green in colour above with scattered fine-grained quartz sand and silt, and branching vesicular structures. Manganous stain and granule line cavities. Fossil vertebrates from top of this unit; articulated skeletal remains may project into the base of the overlying calcareous mudstone (U.C.M.P. localities V 5774, V 5856 and V 5857) . . . . 4ft.

3. *Calcareous mudstone.*—White dolomitic calcareous mudstone, nodular at base, lenses and clayballs of green claystone above. Scattered fine-grained quartz sand and silt and manganous stain and granules throughout . . . . 2-3ft.

4. *Arenaceous claystone.*—Base an intraformational breccia, angular to subangular fragments of white calcareous mudstone in black arenaceous claystone passing to scattered subrounded calcareous mudstone pebbles in black arenaceous claystone matrix 2ft. above base. Above 2ft. gray-green arenaceous mudstone with locally abundant abraded fish and reptile remains. Mottled red and green at top due to infiltration of fractures by red Tirari sands . . . . 3-5ft.

Disconformity

TIRARI FORMATION

Red arenaceous claystone.—Base locally with 1-2in. poorly sorted, medium to coarse-grained quartz sand with coarse grains of duricrust and ironstone. Arenaceous component finer grained toward top. Formation dominantly a red claystone, but occasionally mottled green, with scattered manganous stain throughout . . . . 5-14ft.

Disconformity

KATIPIRI SANDS

Floodplain and channel sands.—At base cross-bedded, poorly-sorted, subangular to subrounded, fine to medium-grained quartz sand with clayballs, argillaceous lenses, and pipey gypsum cemented sandstone concretions. Toward top sands are finer grained and better sorted, with green and red claystone lenses. Limonite stain throughout . . . . 8-22ft.

Disconformity

Wind rift dunes.

D. Lake Ngapakaldi. In ascending order:

ETADUNNA FORMATION (base not exposed)

1. *Green claystone.*—Gray-green to green claystone with scattered fine-grained quartz sand and silt. Branching vesicles throughout. Walls of vesicles encrusted with limonite and tiny manganous granules. Fossil mammal remains at top (U.C.M.P. locality V 5858) . . . . + 3ft.

2. *Calcareous mudstone.*—White dolomitic calcareous mudstone with scattered fine-grained quartz sand and silt; manganous stain on joint surface. Occasional fossil mammal remains at base . . . . . 2ft.

3. *Green claystone.*—At base intraformational breccia, fragments of gray calcareous mudstone in green clay matrix. Limonite stained green claystone above . . . . + 2ft.

4. *Arenaceous claystone.*—At base of exposure green arenaceous claystone with red claystone lenses passing to more dominantly red arenaceous claystone 1-2ft. above base . . . . + 5.5ft.
[Covered interval]

5. *White sandstone.*—White fine-grained quartz sand with green and red claystone lenses . . . . 1ft.

6. *Green claystone.*—Green claystone with abundant limonite stain, increasing in ferruginization toward top. One to two inch calcareous shale stratum 8ft. from base . . . . 18ft.

Disconformity

Tirari Formation

Red siltstone.—Red siltstone with considerable fine to medium-grained quartz sand . . . . 3ft.

Disconformity

Katipiri Sands

Floodplain sands.—Buff, cross-bedded, fine-grained quartz sand. Gypsum cemented at base and upper 6ft. . . . . + 7ft.

Disconformity

Wind rift dunes.

E. Katipiri waterhole, Cooper Creek. In ascending order:

Tirari Formation (base not exposed)

Arenaceous claystone.—Red and green mottled arenaceous claystone becoming dominantly green at top. Lenticular 3in. band of nodular calcareous claystone 1-3in. from top. Limonite and manganous stain throughout . . . . + 11ft.

Disconformity

Katipiri Sands (Type locality)

Channel sands.—Cross-bedded quartz sands. At base white, yellow or orange (limonite stained) poorly sorted, subangular to subrounded, fine to medium-grained quartz sand with coarser sand and pebbles of duricrust, black chert and silicified limestone. Clayballs, ferruginous sandstone concretions, ferruginous sandstone casts of logs and abraded fossil fish, reptile, bird and mammal remains at base (U.C.M.P. locality V 5861). Toward top sands better sorted, white to buff, fine-grained, subangular to subrounded quartz sand. Gray arenaceous clay lenses and platy, spheroidal and pipey gypsum cemented sandstone concretions throughout . . . . 0-17ft.

Disconformity

Unnamed unit.

Channel sands.—Large scale cross-bedded, gray to gray-brown, argillaceous sands, frequently at base a white, poorly sorted, fine to medium-grained, subangular to subrounded quartz sand and gray more argillaceous lenses. Above dominantly gray or gray-brown fine bedded shale lenses with fine quartz sand on the shaly partings. Cuts to top of Tirari formation at western end of Katipiri waterhole where maximum thickness measured . . . . 0-17ft.

Disconformity

WIND RIFT DUNE DEPOSITS

1. *Orange consolidated dune sands.*—Poorly sorted, medium to fine-grained, subangular to subrounded quartz sands. Massive in appearance with scattered small calcareous sandstone nodules . . . . + 10ft.

2. *Buff dune sands.*—Sands forming the existing sandridge system and making up the crest of Katipiri Hill . . . . ± 20ft.

SUMMARY

The paucity of the fossil record of Australasian mammals prompted the initiation of a series of explorations of the continental Cenozoic deposits of the Lake Eyre Basin by the South Australian Museum and the Museum of Paleontology of the University of California. This paper presents the stratigraphic results and preliminary identifications of the faunas obtained from the middle and later Cenozoic deposits of the Tirari Desert east of Lake Eyre North.

The Cenozoic section in this area begins with the Etadunna Formation (Stirton, 1955), nearly 100 feet of green lacustrine claystone, sandstone, calcareous mudstone and dolomitic limestone, resting unconformably on duricrusted non-marine late Cretaceous rocks referred to the Winton Formation. The Etadunna Formation contains an assemblage of gastropods, ostracodes, fish, reptiles, birds and marsupials known as the *Ngapakaldi fauna* (new name). This fauna may be Oligocene in age.

In one local area at Lake Palankarinna the Etadunna Formation is overlain unconformably by thin stream channel deposits termed the *Mampuwordu Sands* (new name). The base of the Mampuwordu channels have yielded the Palankarinna fauna partially described by

Stirton (1955). This fauna is questionably assigned to the early Pliocene.

Overlying the Mampuwordu Sands disconformably, or resting directly on the Etadunna Formation with local angular unconformity, are the unfossiliferous red-beds of the *Tirari Formation* (new name). Locally the Tirari Formation may include nearly 40 feet of flat-lying brick red argillaceous sandstone and arenaceous claystone, but usually it is much thinner due to deep erosion prior to the deposition of the overlying fluviatile deposits. The Tirari Formation is questionably assigned a Pliocene age on the basis of its stratigraphic position.

Cutting deeply into the Tirari Formation is a complex of fluviatile deposits of varying thickness termed the *Katipiri Sands* (new name). These deposits contain two faunas of probable Pleistocene age. The ?early Pleistocene *Kanunka fauna* (new name) is represented by remains of crustaceans, fish, reptiles, birds, marsupials and rodents as is the later Pleistocene *Malkuni fauna* (new name).

These fossiliferous channel and flood plain sands are overlain locally by later fluviatile deposits or by the sandridge system of the Tirari Desert.

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RE-EXAMINATION OF THE SPECIES OF PROTURA DESCRIBED BY H. WOMERSLEY

By S. L. Tuxen, Zoological Museum, Copenhagen, Denmark

Summary

Within the framework of my re-examination of the species of Protura described prior to 1945 (and a few others), I have long felt the need to examine the species described by H. Womersley. This author in 1924 first reported the finding of Protura in England with specimens then determined as the well known species Acerentomon doderoi Silv. Later (1927-28) he described this material as a new species (A. bagnalli), together with six other new species from the British Isles. Late in 1929 Womersley was appointed to the Australian Council for Scientific and Industrial Research to work in Western Australia on the Lucerne Flea and Red Earth Mite problem. On his way to Australia he spent some weeks in the Cape Town region of South Africa on this problem and there collected a species of Protura which he later described (1931). Since that time he has described eight species and one subspecies from Australia and two species from the United States of America.

RE-EXAMINATION OF THE SPECIES OF PROTURA DESCRIBED BY H. WOMERSLEY

By S. L. TUXEN, Zoological Museum, Copenhagen, Denmark

Fig. 1-98

Within the framework of my re-examination of the species of Protura described prior to 1945 (and a few others), I have long felt the need to examine the species described by H. Womersley. This author in 1924 first reported the finding of Protura in England with specimens then determined as the well known species *Acerentomon doderoi* Silv. Later (1927-28) he described this material as a new species (*A. bagnalli*), together with six other new species from the British Isles. Late in 1929 Womersley was appointed to the Australian Council for Scientific and Industrial Research to work in Western Australia on the Lucerne Flea and Red Earth Mite problem. On his way to Australia he spent some weeks in the Cape Town region of South Africa on this problem and there collected a species of Protura which he later described (1931). Since that time he has described eight species and one subspecies from Australia and two species from the United States of America.

Through the kindness of Mr. Womersley and the Board and Director of the South Australian Museum, Adelaide, I have been privileged to borrow the whole of his collection of Protura, now in the South Australian Museum. A few species not present in this collection have been most kindly lent to me by Dr. A. J. Hesse of the South African Museum, and Dr. Theresa Clay of the British Museum (Nat. Hist.), London. To all these scientists and institutions I extend my warmest thanks for their comprehending co-operation. The 18 species and one subspecies described by Womersley, including one species renamed by Bonet, are the following:

1. *Eosentomon westraliense* Wom. 1932.
2. *Eosentomon swani* Wom. 1932.
3. *Eosentomon millsi* Wom. 1938 from U.S.A.
4. *Eosentomon millsi* Wom. 1939 from Australia = *E. womersleyi* Bonet 1942.
5. *Eosentomon millsi* var. *australica* Wom. 1939.

6. *Paraentomon clevedonense* Wom. 1927.
7. *Proturentomon iowaense* Wom. 1938.
8. *Acerentomon bagnalli* Wom. 1927.
9. *Acerentomon nemorale* Wom. 1927.
10. *Acerentomon oblongum* Wom. 1927.
11. *Acerentomon metarhinus* Wom. 1928.
12. *Acerentomon agrorum* Wom. 1928.
13. *Acerentomon pinus* Wom. 1928.
14. *Acerentulus capensis* Wom. 1931.
15. *Acerentulus westraliensis* Wom. 1932.
16. *Acerentulus australiensis* Wom. 1932.
17. *Acerentulus tillyardi* Wom. 1932.
18. *Acerentulus occidentalis* Wom. 1932.
19. *Acerentulus sexspinatus* Wom. 1936.

These species will be dealt with in the above order and in accordance with my earlier type of re-examination, *i.e.*, with special reference to the setae and sensillae on the foretarsus, the filamento di sostegno and abdominal combs in the *Acerentomidae*, the female squama genitalis and the third tarsus in the *Eosentomidae*, as well as the chaetotaxy, although other characters will be considered where necessary. The numbering of the setae and sensillae follows my plan from earlier papers (Tuxen 1956-60, Bonet and Tuxen 1960). All figures are original.

Womersley marked several of his slides as "Type" but not, however, for all species and in several cases slides of the different stages of a species were also similarly marked.

I have, therefore, disregarded this as a regular designation of a holotype—in his papers no holotypes are designated—but have selected a lectotype for each species preferably from amongst the slides marked "Type". Only in cases where the description is based on a single individual has this been regarded as a holotype.

1. Eosentomon westraliense Womersley

Eosentomon westraliensis Womersley 1932 p. 73, fig. 4-6, 17-18.

Eosentomon westraliense Womersley 1939 p. 287, fig. 79 F-I.

Fig. 1-9.

This is the first *Eosentomon* described by Womersley and the description was based on statements of length in μ and on the chaetotaxy. In 1939 the description was repeated almost word for word, but the drawings were new. In his collection one slide of a male from "King's Park, Perth, Western Australia, 21st April 1931" is marked as "Type". I take this as a lectotype. Two other slides are marked "Paratype". One of these, a larva 2 from "Crawley, W.A. 10th October, 1931, D. C. Swan" may be a paratype though it is not mentioned in the first description; the other one, however, a female from Glen Osmond, South Australia, 9th July 1933, cannot be a paratype, being found after the publication of the original description. I may, however, select it as a neo-allotype, because the shape of the female genitalia is so important for the understanding of the species of the genus *Eosentomon*.

The foretarsus, fig. 1-2, shows the following characteristics: t1 is slightly pointed, elongate oval, and set much nearer to $\alpha 3$ than to $\alpha 3'$. The distal part from t1 (termed d) is almost exactly equal to the proximal part from t1 (called p), so that d:p = 1.00[1], a is very short, a′ long and exceeding the tip of t1, d is longer than t2.

Especially remarkable is the position of c′ quite near to b′1 and b′2; the tip of s is shortly club-shaped; the empodium is long in relation to the claw, ratio e:u (empodium to unguis) = 0.9; TR (ratio claw to tarsus) is stated by Womersley to be 6.0 but I am unable to make it more than 5.0.

The shape of the head is given in fig. 3 drawn from the neo-allotype. The pseudoculi are very large, 1:6 of the head length, but broader than shown in the figure, where they are seen in foreshortened view. The mouth parts (fig. 4) are very much like those of *E. wheeleri* Silv. (Bonet and Tuxen 1960). The mandibles are striated in the outermost part, and their tips are not smoothly rounded but with three very small "teeth". There is a structure (hyp) which may be the hypopharynx seen by Prell in 1913, but not by me in *Acerentomon* (Tuxen 1959).

Tarsus III (fig. 5) with a very stout spine. The chaetotaxy (fig. 6-7) is as follows, the pleural setae being included in the number of tergal setae:

	I	II-III	IV-V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{4}{8}$	$\frac{10}{14}$	$\frac{10}{16}$	$\frac{8^{(2)}}{16}$	$\frac{4^{(3)}}{16}$	$\frac{6}{7}$	8	8	8	$\frac{6+2^{(4)}}{3}$
s	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	7	4	4	8	$\frac{8^{(5)}}{4}$

(1) The importance of this ratio was stated by Bonet and Tuxen (1960 p. 27) for *E. wheeleri* Silv. Unfortunately by a slip the ratio was given as 8:7 = 1:15. It should read 7:8 = 0.88.

(2) "3" is missing; (3) "1-3" are missing; (4) very small, almost points; (5) 6 long and 2 small setae.

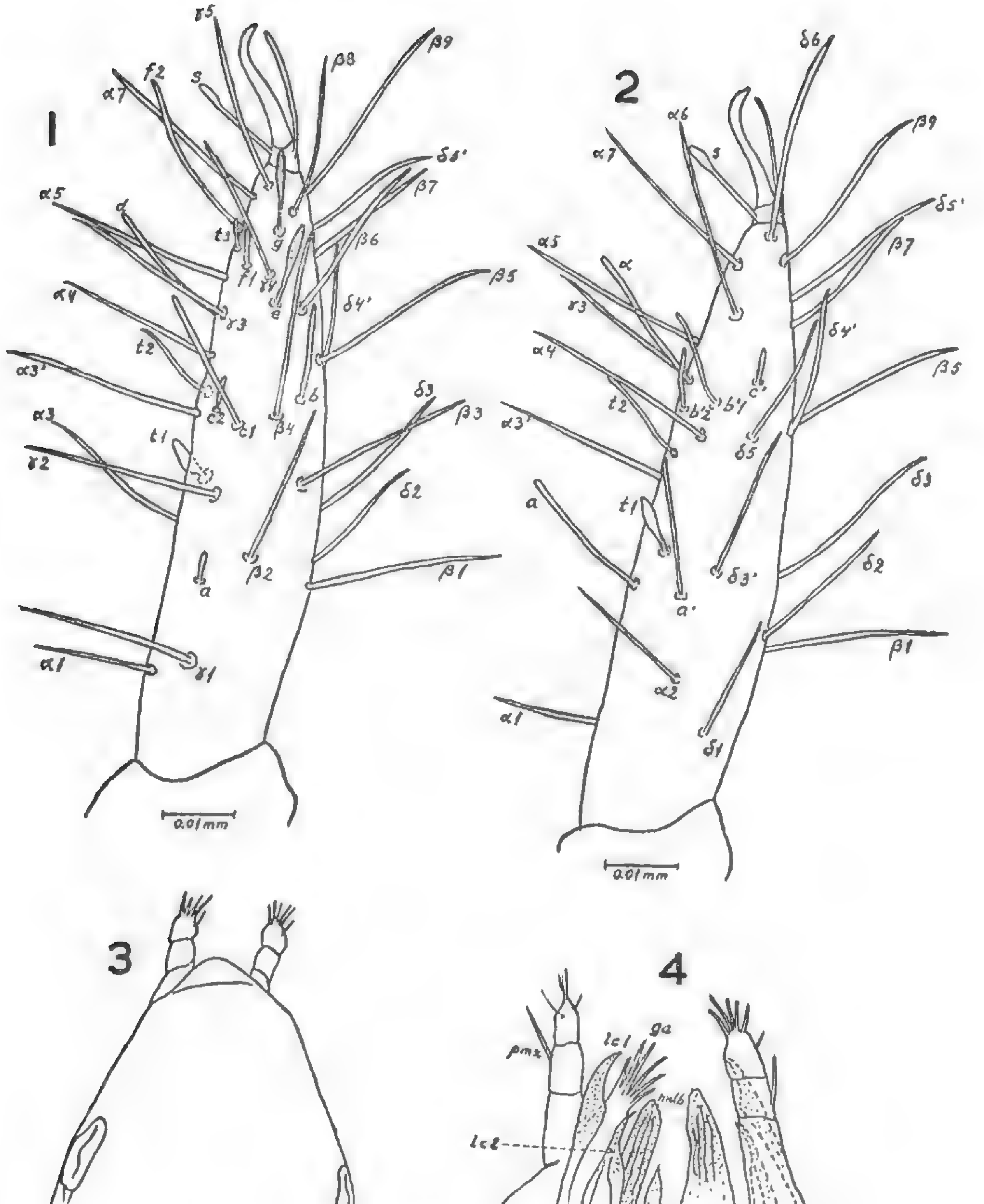

Fig. 1-4. *Eosentomon westraliense* Wom. 1, exterior side foretarsus of lectotype ♂; 2, interior side of same; 3, contour of head of neo-allotype ♀; 4, mouth-parts of lectotype ♂ — ga, galea; hyp, ?hypopharynx; lc 1 and 2, lacinia; mdb, mandible; pmx, maxillary palpus.

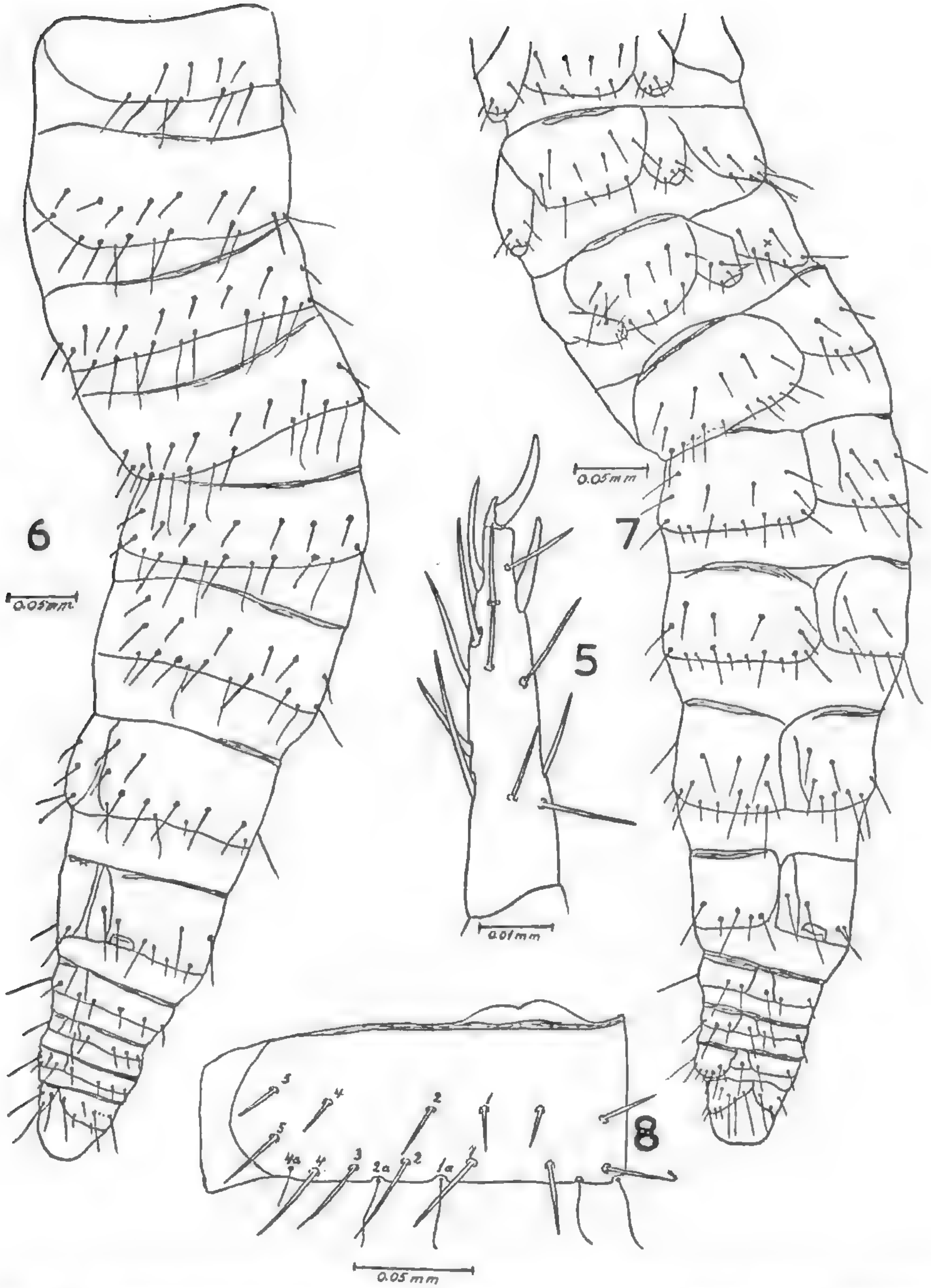

Fig. 5-8. *Eosentomon westraliense* Wom.; Lectotype ♂. 5, right tarsus III; 6, abdominal tergal chaetotaxy; 7, abdominal sternal chaetotaxy; 8, chaetotaxy of sixth abdominal tergum with numbering of setae.

The chaetotaxy does not entirely agree with the figures given by Womersley 1932 and 1939, which also do not agree. It is, however, identical in the type specimen (male) and the neo-allotype except for an individual variation in the former; the posterior row on tergite III shows 8 setae on the right side (shown in fig. 7 where the supernumary seta is marked "X"). Fig. 8 is part of the sixth tergite showing the length and enumeration of the setae; the thin accessory setae "1a" and "2a" are as long or longer than the principal ones on all tergites except "1a" on tergite VII.

The squama genitalis of the female neo-allotype is shown in fig. 9. The actual shape of the processus sternales (p.st.) is rather difficult to see and is different from that of all other species known to me.

Lectotype: a male from "King's Park, Perth, W.A., 21/4/31".

Neo-allotype: a female from "Glen Osmond, S.A., 9/7/33".

Both in the South Australian Museum collection.

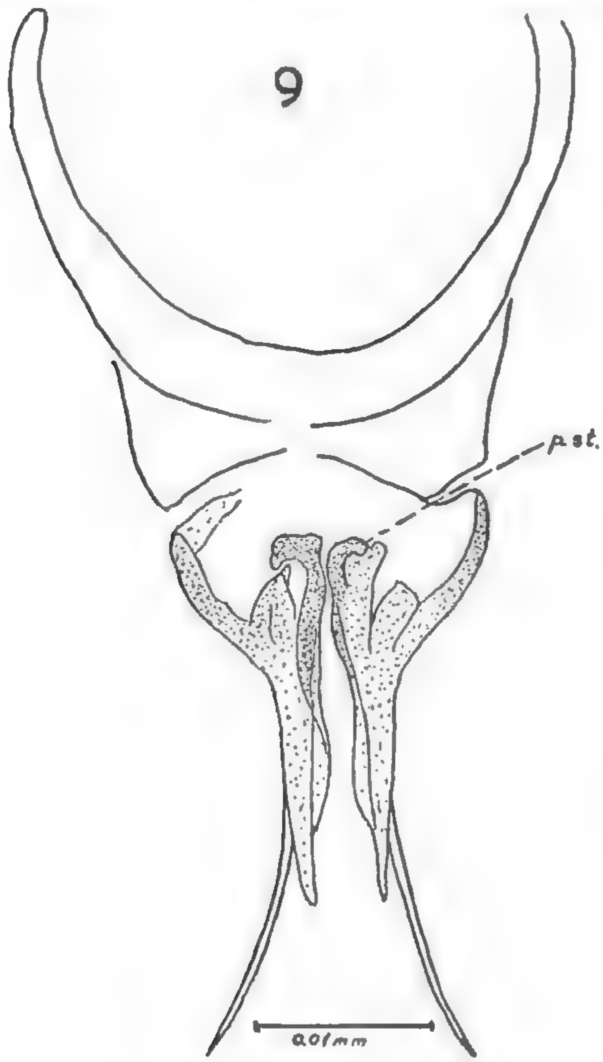

Fig. 9. *Eosentomon westraliense* Wom.; Neo-allotype ♀. Squama genitalis from dorsal side—p.st., processus sternales.

2. **Eosentomon swani** Womersley

Eosentomon swani Womersley 1932 p. 75, fig. 7-8, 19-20; 1939 p. 287, fig. 79 A-E.

Fig. 10-16.

The description gave only the measurements in μ of parts of the body and the statement "chaetotaxy as figured". In 1939 it is repeated almost word for word, but the figures of the chaetotaxy of t VII-IX differ slightly. In a key on p. 289 (1939), there is an important new statement "tarsus III without a strong subapical dorsal spine". This, however, is incorrect. In the collection are two slides both marked "Type"; one, a female, I take as a lectotype; other slides are marked as paratypes. The following new description is of the lectotype.

The foretarsus (fig. 10-11) is much broader in relation to length than in *westraliense*, or in fact in most *Eosentomon* species known to me; t1 is relatively large and placed on a level with $\alpha 3$; thus being much nearer to the distal than to the proximal end of the tarsus, d:p = 1.36; t2 is short and slender, t3 relatively long, a is rather short, b thicker than the other sensillae, a′ very long and reaching to the tip of t1. Very curious is the long and sinuate c′, s is long with pointed club. TR = 4.5, e:n = 0.85.

The shape of the head is shown in fig. 12; the pseudoculi are rather small, about $\frac{1}{11}$ of the head. The mouth parts are shown in fig. 13; the mandibles are striated as in *E. westraliense*, and also like *E. vermiforme* Ewing (see Bonet and Tuxen 1960 p. 273).

Tarsus III (fig. 14) has a very distinct subapical spine.

The chaetotaxy is as follows:

	I	II-III	IV-VI	VII	VIII	IX	X	XI	XII
t	$\frac{4}{8}$	$\frac{8^{(6)}}{16}$	$\frac{8^{(6)}}{16}$	$\frac{4^{(7)}}{16}$	$\frac{6}{9^{(9)}}$	8	8	8	$\frac{6+2^{(8)}}{3}$
s	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{2}{7}$	4	4	8	$\frac{8}{4}$

The chaetotaxy of t VI is given in fig. 15; "1a" is abnormally missing on the left side.

The squama genitalis of the female (fig. 16) shows two distinct V-shaped proximal sclerites, probably the processus sternales, but appearing as if free of the distal sclerites of the acrogyne.

(6) "3" is missing in t II-IV, although found on the left side of t II; (7) "1", "3", and "5" are missing; (8) almost points; (9) a small seta quite near the glandular opening, absent in *westraliense*.

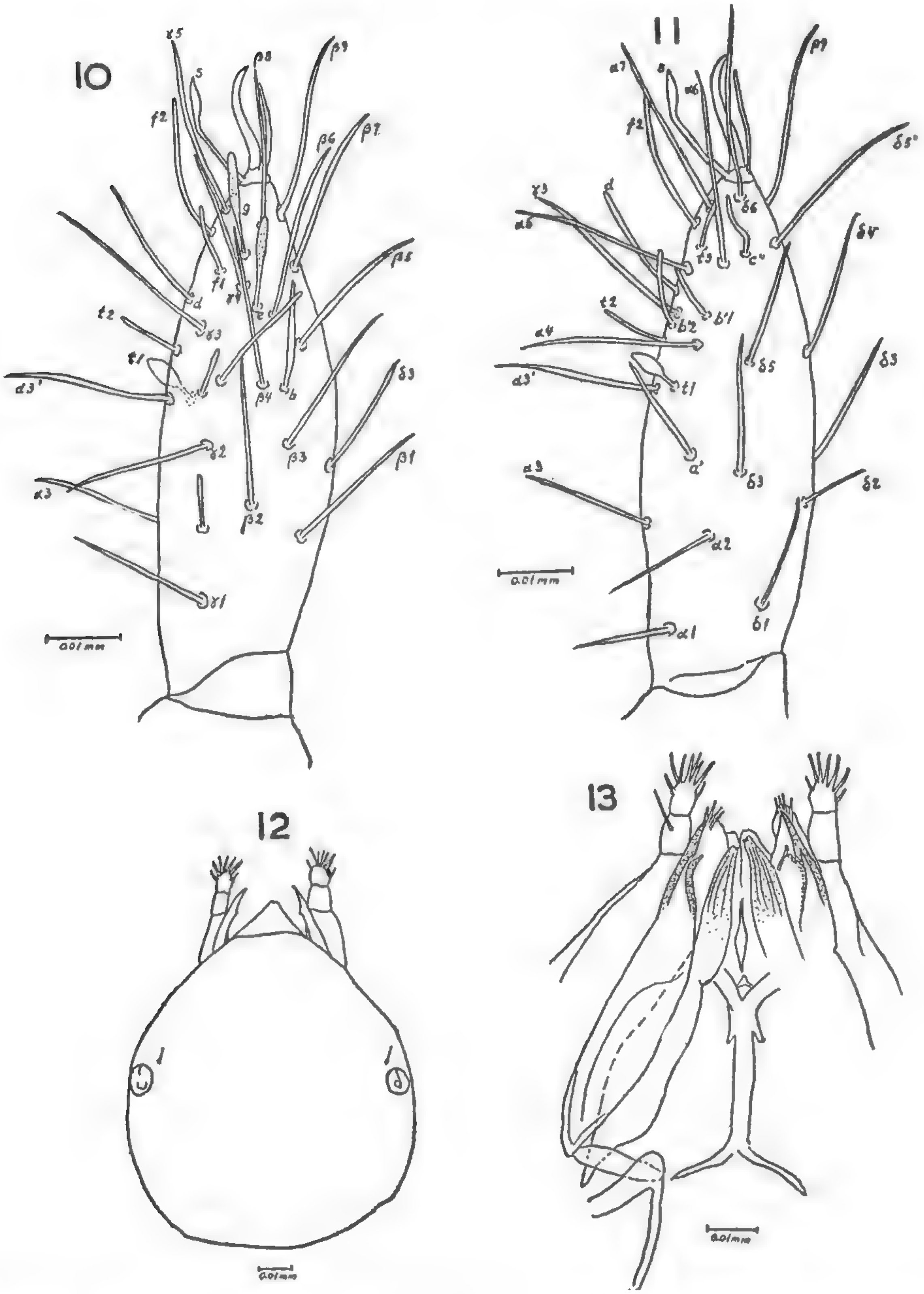

Fig. 10-13. *Eosentomon swani* Wom.; Lectotype ♀. 10, foretarsus, exterior side; 11, interior side of same; 12, contour of head; 13, mouth-parts, compare with fig. 4.

Lectotype: A female from "in moss, Crawley, Western Australia, 27/7/1931, D.C. Swan" in the South Australian Museum.

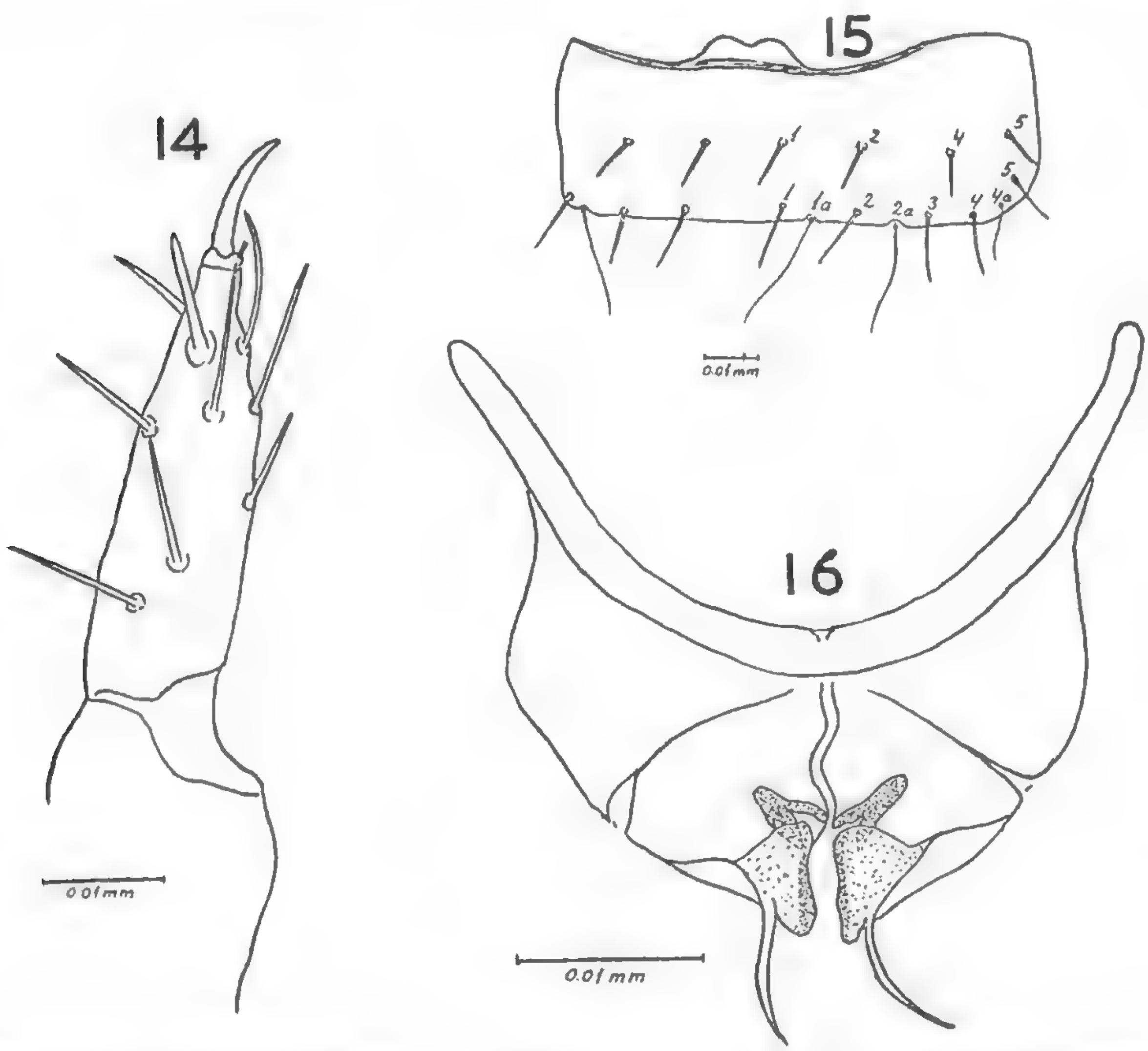

Fig. 14-16. *Eosentomon swani* Wom.; Lectotype ♀. 14, left tarsus III; 15, tergal chaetotaxy of sixth abdominal segment; 16, squama genitalis from ventral side.

3. **Eosentomon millsi** Womersley

Eosentomon millsi Womersley 1938 p. 221, pl. XII fig. D-G.

?*Eosentomon armatum*, Mills 1932 p. 130; nec *E. millsi* Womersley 1939 (= *E. womersleyi* Bonet 1942), *vide* p. 16.

This species was described by Womersley in 1938 from specimens sent to him by Dr. Harlow B. Mills from Iowa, United States of America, and probably the same as Mills referred to in 1932 as *E. armatum* Stach. In 1940 Ewing, without giving any reason, synonymised the species with *E. wheeleri* Silv. This synonymy has since proved to be correct. In 1939 Womersley recorded the species from Australia but Bonet in 1942 considered the Australian material as another species which he named *womersleyi* nom.nov. (see the following species).

In Womersley's collection are several slides of this species from the U.S.A.; one, a female without fore-legs, marked as the type; I have examined the characters of the fore and hind tarsi, the squama genitalis of the female and the chaetotaxy, and find complete agreement with *E. wheeleri* Silv. as redescribed by Bonet and Tuxen in 1960, and also in respect to the very long accessory setae in the posterior rows of the tergites. It is therefore unnecessary to give any figures. The synonymy given by Ewing, although he did not have an exact knowledge of *wheeleri* nor of the type material of *millsi*, is therefore justified.

Lectotype: A female from "Columbus Jnt., Iowa, U.S.A., 26/9/38" (probably an error for "1939 H. B. M(ills)") in the South Australian Museum.

4. **Eosentomon womersleyi** Bonet

Eosentomon millsi Womersley 1939 p. 287, fig. 79 J-M; nec *E. millsi* Womersley 1938 p. 221.

Eosentomon womersleyi nom.nov. Bonet 1942 p. 16.

Fig. 17-23.

In his work on the Australian Apterygota 1939 Womersley recorded his *Eosentomon millsi* from Australia. He gave a description which is word for word identical with that of *millsi* 1938 except that a line (line 3, p. 289) had fallen out, the result being that the spine appears to be present on tarsus II. The figures, however, were new and different from those of 1938—it should be noted, however, that the figures of the chaetotaxy of *millsi* in 1938 were incorrect. From the difference in these figures Bonet concludes quite laconically: "pero basta comparar las respectivas figuras . . . para convencerse de que se trata de formas distintas"; he gives no further description but, without having seen the type, gives it the name *womersleyi* nom.nov.

As the figured chaetotaxy might have been wrong—as it is in both cases—the procedure of Bonet was rather audacious. Unfortunately only one specimen of *millsi* from Australia is present in Womersley's

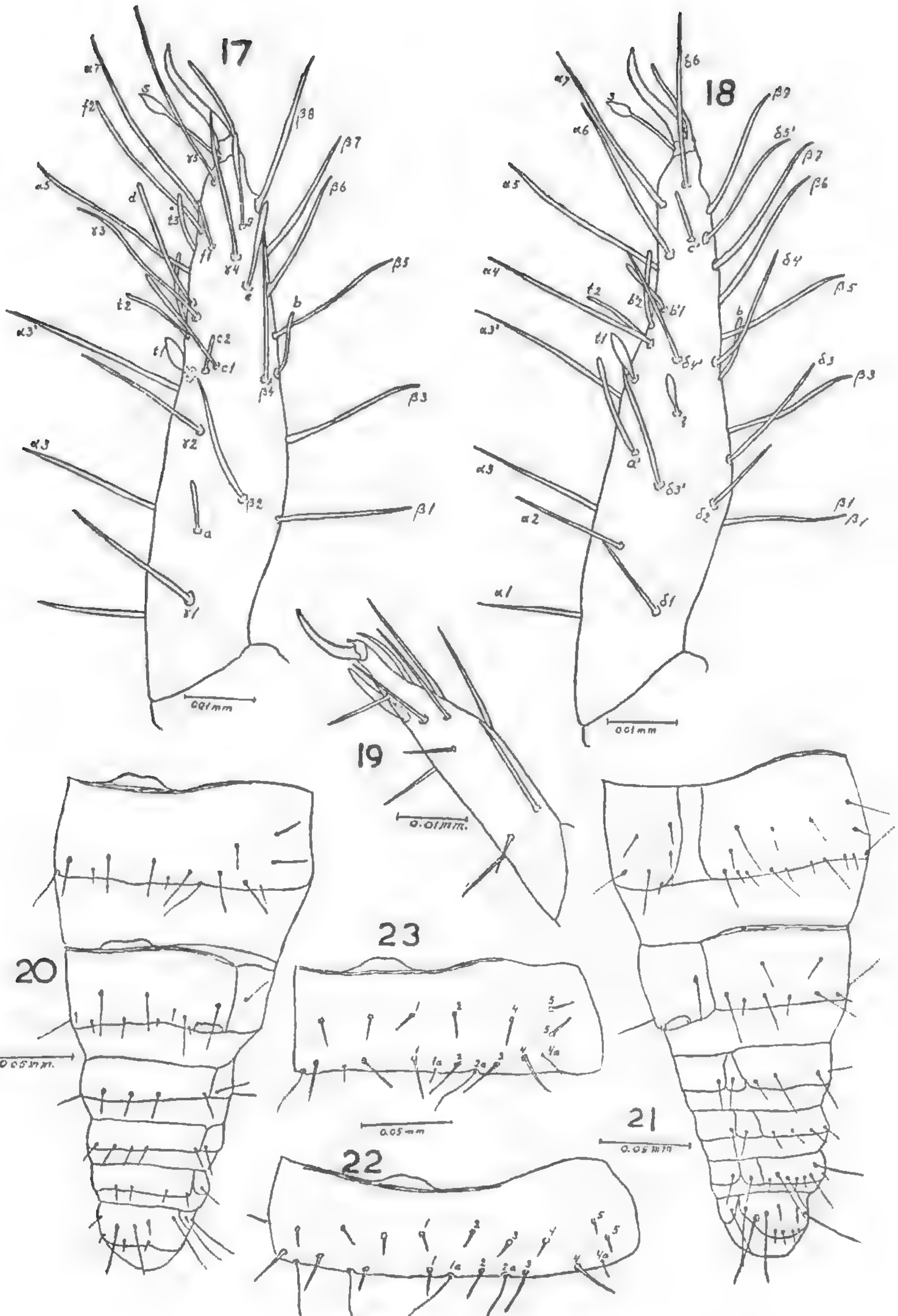

Fig. 17-23. *Eosentomon womersleyi* Bonet; Holotype ♂. 17, foretarsus, exterior side; 18, interior side of same; 19, left tarsus III; 20, tergal chaetotaxy of abdominal segments VII-XII; 21, sternal chaetotaxy of same; 22, tergal chaetotaxy of second segment with numbering of setae; 23, same of sixth abdominal segment.

collection and Womersley himself has added to the label "*womersleyi* Bonet 1942 nec *millsi* Wom. 1938" and the word "Type". This slide may be taken as the holotype. The specimen is a male and is described as follows, though of course without reference to the female genitalia.

The foretarsus (fig. 17-18) is first and foremost characterised by a redoubling of t1 on the interior surface, a feature not seen by me in any other *Eosentomon*. This occurs on both legs but may, of course, be an individual character. The sensillae and setae are mostly as generally found, a seems rather shortly club-shaped but the club is seen fore-shortened in the figure; t1 is placed far advanced, even distal to *a3′* and on a level with sensillae c1 and c2, d:p therefore = 0.65, even shorter than in *wheeleri*. TR = 5.3, e:u = 1.3, δ 5 is missing. Tarsus III (fig. 19) with a distinct spine.

The shape of the head cannot be given as it is broken. The mouthparts are as in *westraliense* and *swani*, the mandibles with striae.

The chaetotaxy (fig. 20-21) also shows several characteristics and schematically is as follows:

	I	II	III	IV	V-VI	VII	VIII	IX	X	XI	XII
t	4/8	10/16	8[10]/16	8[10]/16	8[10]/16[11]	4[12]/16[11]	0/9	8	8	8	9
s	4/4	6/4	6/4	6/10	6/10	6/10	2/7	4	4	8	12

There are many curious features in this chaetotaxy; "3" is missing in the anterior row of t III-VI (in t VII "1" and "2" are also missing), thus abdomen II and III are different.

The accessory setae "1a" are longer than the principal ones on abd. II-IV, as are "2a" on all segments, but they are shorter on abd. V-VII; in all other species of *Eosentomon* known to me this only holds good for abd. VII. It is worthy of notice that the accessory setae "1a" are placed inside the border of the sclerite when they are short, but immediately outside when they are long (see fig. 22-23). This occurs in all species of *Eosentomon* known to me.

The two lateral setae on sternite IX are short and the two median long; on sternite X, however, all four are short.

The chaetotaxy and the foretarsus appear to me therefore to justify the regarding of this specimen as a separate species.

Holotype: A male from "Brown Hill Creek, Adelaide, S.A., 5th June 1932 D. C. Swan" in the South Australian Museum.

(10) "3" missing; (11) "1a" is very short; (12) "1-3" are missing.

5. **Eosentomon womersleyi** Bonet var. **australica** Womersley

Eosentomon millsi var. *australica* Womersley 1939 p. 289, fig. 79 N-Q.

In 1939 Womersley further described a variety of his *E. millsi.* Although from the description there should be several slides from various parts of South Australia, no slide with this name is present in the collection. In the text Womersley gives the following differences from the typical form: sternite VIII with no anterior row of setae, and on sternite IX (sic. "tergite" in error) the lateral setae are much smaller than the median. His fig. 79 Q also shows this, but as stated above, his figure of the typical form is wrong in respect to sternite IX, the difference in size of the lateral and median setae being present also in this form. In the key on p. 289 he further says that the accessory seta "2a" in the posterior row of tergite VII in var. *australica* is absent; this is very improbable.

There remains, therefore, only one character separating the two forms, viz., the absence of the anterior row of setae on sternite VIII. If then, a form of *E. womersleyi* Bonet with s VIII = $\frac{0}{7}$ be found and proved not to be an individual variation, then the var. *australica* Wom. is a reality; till then we cannot say more of its existence. No holotype or lectotype.

6. **Paraentomon clevedonense** Womersley

Paraentomon clevedonense Womersley 1927a p. 145, fig. 4-7.

Proturentomon minimum Bagnall 1936 p. 212; Tuxen 1956a p. 241, fig. XIII-XV.

Fig. 24-27.

Of this British species which was described from three specimens "taken with others under deeply-embedded stones above Norton Wood, Clevedon, Som., 21.IX.1926. Found also in a similar habitat on Backwell Hills, Som., 16.X.1926", I have had two "type slides" before me, one from the South Australian Museum marked "Co-type, Clevedon, Oct. 1926, H. Womersley" and the other from the British Museum (Nat. Hist.) coll. Bagnall, marked "Paratype, West Town, Som., 10/10/26 H. Womersley" (both are determined as *Paraentomon clevedoniensis*, with the female adjectival ending). Neither of these belong to the series from Norton Wood, Somerset, England; but as both belong to the type material, I select the South Australian Museum specimen as the lectotype, because although smashed, it shows the characters, including the mouth-parts, very well.

Already in his description 1927 Womersley had stressed the resemblance to *Acerentulus minimus* Berlese, but Berlese had not observed that the second abdominal leg resembled the first but not the third and consequently Womersley had to replace his species in a new genus and even a new subfamily. Later Bagnall (1936) for quite theoretical reasons synonymised the two species, to which Womersley himself agreed in 1938, and which I myself in 1956 confirmed after having seen the type of *A. minimus* Berl.

In 1956 I gave a detailed description of the species, based on specimens from Rothamsted, England and sent to me by Dr. F. Raw under the name of *Proturentomon minimum* Berl. The type of Berlese's species was not fit for description although suitable for the checking of important characters. I have now checked the above type specimens of *clevedonense* (one on each slide) with my 1956 description and with the specimens from Rothamsted and find the closest resemblance so that it is unnecessary to draw or describe the lectotype of *P. clevedonense*, only some corrections and additions to my description of 1956 need be given.

The mouthparts (fig. 24) are very clear on the lectotype owing to its smashed state, wherefore I have thought fit to figure them. The shape of the mandible is important, shorter and stouter than in *Acerentulus* and with a long and distinct slit; in the maxillae the galea could not be seen. The pseudoculus is very peculiar, the "lever" being long triangular and nearly as broad as the "lid".

The last abdominal segments (fig. 25) show rows of very small teeth on the hind border of the ninth, tenth and eleventh tergite, and a small "lunula" of teeth on the middle of tergite XII.

The chaetotaxy. In 1956 (p. 244) I gave t VIII $\frac{8}{12}$ and s X 2. Both these statements were due to having chosen an aberrant specimen for drawing. In this specimen (fig. XV 1) there were 7 setae in the anterior row on t VIII, but an examination of all the Rothamsted specimens as well as the present lectotype shows that there was a seta too many in the figured specimen and not one too few. The ventral view (fig. XV 2) was drawn from another aberrant specimen with only 2 setae on s X and 8 on s XII; the correct numbers are four and six. The examination of the present lectotype has further shown that my stating $\frac{4}{2}$ for s I, which was given with a question mark, is correct.

In an examination of the 19 adult specimens of this species I have found two specimens with only two setae on s XI. This is a feature of the maturus junior of *Acerentulus* (at least *danicus* Condé); only

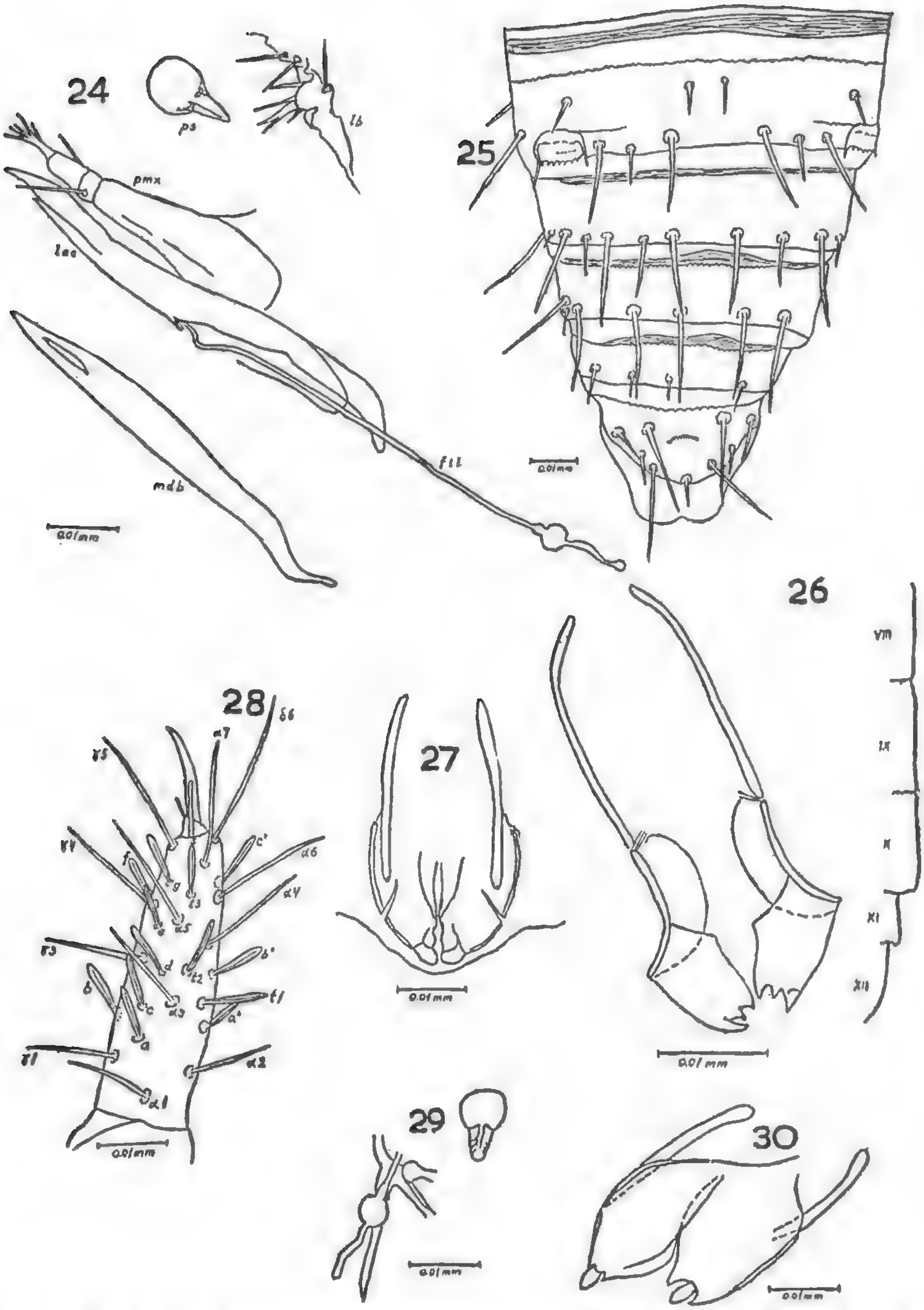

Fig. 24, 25 and 27. *Paraentomon clevedonense* Wom.; Lectotype ♀. 24, mouth-parts—fil, filamento di sostegno; lac. laciniae; lb, labium; mdb, mandible; pmx, maxillary palpus; ps, pseudoculus; 25, chaetotaxy of tergites VIII-XII; 27, squama genitalis.

Fig. 26. *Proturentomon minimum* Berl. ex Rothamsted, leg. Raw. genital squama of male?

Fig. 28-30. *Proturentomon iowaense* Wom.; Lectotype ♀. 28, left foretarsus from above; 29, filamento di sostegno and pseudoculus; 30, squama genitalis.

in one of these specimens, however, I could see the genitalia, and these seemed to differ from those of all other specimens (fig. 26). In fig. 27, I have drawn the genitalia of the lectotype of *clevedonense* which on comparison with Berlese's figure (Tav. IX, fig. 105) I would assume to be a female squama. All the specimens except the abovementioned have this squama and I have not seen one which I could, without doubt, consider a male. Whether the above specimens with s XI 2 are males or immature specimens, I do not venture to decide.

Lectotype: female from "Clevedon, Oct. 1926, H. Womersley", in the South Australian Museum, Adelaide.

From the above the long supposed synonymy of *Paraentomon clevedonense* Wom. with *Proturentomon minimum* Berl. and *Paraentomon* Wom. with *Proturentomon* Silv. will be evident. (The *Paraentomon* species of Ionescu belong to another genus, *Ionescuellum* Tuxen 1960.)

7. **Proturentomon iowaense** Womersley

Proturentomon iowaense Womersley 1938 p. 221, pl. XII, fig. a-c.

Fig. 28-30.

This species was described without the designation of a holotype, or a statement of the number of specimens available. The description was reprinted by Ewing 1940 (p. 531) but nothing new was added. It was said to differ from *P. clevedonense* only in the absence of the two small anterior setae on tergites V and VI, and in the length (585μ as against 900μ). This latter, however, is incorrect, the length being about 800μ.

I have before me four slides of one specimen each; one marked "Type", the others "Paratype". I have selected that marked "Type" as a lectotype because it is best preserved. The species is extremely like the preceding.

The foretarsus (fig. 28) is shown as seen from above (both tarsi). The many sensillae, all equally long and stout, can be seen and may be counted together with the setae as I did for *P. minimum* Berl. in 1956, *i.e.*, in accordance with the numbering of the sensillae and setae in *Acerentulus-Acerentomon*. In this species all the sensillae could be identified with the sole exception of t1; in the present species also t1 is found and this gives a clear difference between the two species, but also more distinctly shows a near relationship to the *Acerentominae*. Womersley described these sensillae in *clevedonense* as having a single median rib, which is clearly seen in the present species but probably is nothing more than an optical phenomenon. The ratio TR is given by Womersley (1938) as a difference between the two species, 3.2 in *iowaense* and 3.0 in *clevedonense*; but in 1927 he gave 2.8 for *clevedonense* and I would measure 2.9 in this species and 3.1 in *iowaense;* these differences, however, are too small and inexact to warrant species differentiation. The pseudoculus and filamento di sostegno (fig. 29) are as in *minimum* Berl. The comb of abd. VIII with many small teeth.

The squama genitalis of female (fig. 30) is difficult to see and understand clearly. I have drawn it as it appears to me in the lectotype; perhaps the differences from fig. 27 are of a specific nature.

The chaetotaxy is in all respects like that in the preceding species except that on tergites V-VI the two small anterior setae are missing as pointed out by Womersley (yet they are on t V in the lectotype). Also the small teeth on the hind margin of t IX-XI and on the surface of t XIII are clearly seen. One of the specimens is a maturus junior without genitalia and with only two setae on s XI.

Lectotype: A female from the United States of America, "Columbus Jnt. Iowa, 26/9/32, H. B. Mills," in the South Australian Museum, Adelaide.

The species is very close to *P. minimum* Berl. differing only in the presence of t1, perhaps the shape of the filamento and squama genitalis, and the absence of the two small anterior setae not only on tergite VII but also on t VI and often on t V.

8. **Acerentomon bagnalli** Womersley

Acerentomon bagnalli Womersley 1927a p. 141 fig. 1.

Fig. 31-37.

This British species was described by Womersley "from a male specimen, one of many taken under old bark . . . Blaise Castle Woods, Bristol, Glos. 27.XII.1926". He mentioned that it is the species he recorded in 1924 as *doderoi* Silv. but does not indicate how it differs from this species. He introduces here two characters not previously used in Proturan taxonomy, viz., the relation between the lengths of the claw and tarsus of the foretarsus (TR) and the relation of the length of the labrum to that of the head (LR). Both characters have since been abundantly used. He also gives points to the chaetotaxy,

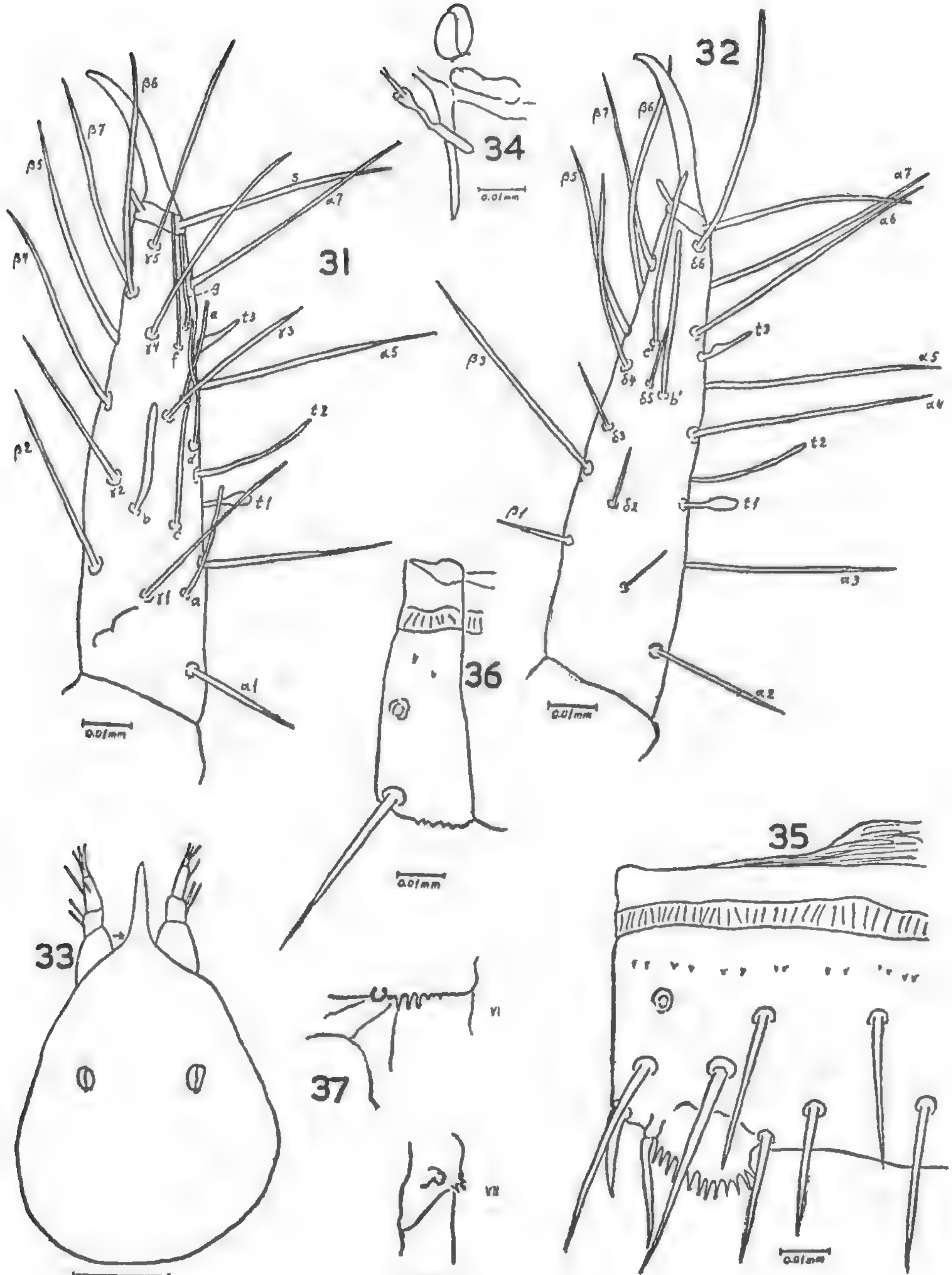

Fig. 31-37. *Acerentomon bagnalli* Wom.; Lectotype ♀. 31, foretarsus exterior side; 32, interior side of same; 33, contour of head, arrow points to base of labrum; 34, filamento di sostegno and pseudoculus; 35, comb of abd. segment VIII; 36, pectine of pleurite VIII; 37, pectines of pleurites VI and VII, sternum to right.

a characteristic the significance of which was later elaborated by Ionescu.

In Womersley's collection twelve slides of this species are present, most of them containing young stages (as to the supposed stage with eleven abdominal segments in this species see my drawings in an earlier paper (Tuxen 1949 p. 47, fig. 72-75)), only two with adult specimens: "Mature female, type" and "submature male, cotype". All slides are from the locality and date mentioned in the description.

There seems every reason therefore, to believe that "male" in the description is a printer's error for "female", the more so as the "submature male cotype" is not a good specimen from which to describe the species. I have thus selected the female as a lectotype and marked it accordingly. It will be described as follows:

The foretarsus (fig. 31-32) with the setae and sensillae arranged as commonly found in *Acerentomon*, t1 is claviform, t2 long and slender, t3 long lancet-like, b much thicker than the other sensillae, e situated about in the middle between d and f, f longer than g. Seta s is very long and straight. On the inner side b′ and c′ are very long with the small δ 5 between them, a′ is missing, β 1 is short, δ 4 very long; TR = 3.0 (Womersley gives 3.4 through a printer's error as his measurements (35μ to 105μ) show; e:u (empodium : unguis) = 1:7.

The head (fig. 33) with LR = 4.3; somewhat flattened in the slide. The filamento di sostegno (fig. 34) with short proximal part and heart-shaped dilation. The shape of the pseudoculus may be seen in the same figure.

The comb on the eighth abdominal tergite (fig. 35) does not reach as far backwards as in *doderoi* and has shorter and fewer (12) teeth; on tergite, pleurite and sternite are found rows of short spines, fewer and much shorter than in *doderoi*. The hind border of the pleurite carries 5 short teeth (fig. 36). In all the above characters the species is clearly distinguished from *doderoi* Silv. (see Tuxen 1960a).

Womersley (*loc. cit.*) mentioned a pectine on the eighth pleurite and fifth tergite. The first one must be a row of teeth on the hind border of pl. VIII mentioned above, the second must refer to a comb found on the anterior part of the sixth pleurite. In my paper on the Protura of Ionescu (1961) I have described these pleural "combs" in the genus *Acerentomon* as specified in the species *Ac. quercinum* Ion. In the present species the pectine on abd. VI carries some three long teeth and a small number of smaller teeth, that on pleurite VII carries two strong and two slender teeth (fig. 37). In this character also this species differs from *doderoi* Silv.

The chaetotaxy is as follows (the pleural setae are included in the tergal count):

	I.	II	III	IV-VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{14}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{8}{13}$	14	10	4	9
s	$\frac{3}{4}$	$\frac{5}{5}$	$\frac{7}{5}$	$\frac{7}{8}$	$\frac{5}{8}$	$\frac{4}{2}$	4	4	6	6

The "co-type male" has s VII $= \frac{6}{8}$. The hind border of s XII is very faintly serrate.

In many characters this species resembles *A. doderoi* Silv. but distinct differences are to be found in the characters of the abdominal pectines as well as in the chaetotaxy, t VII having $\frac{13}{15}$ in *doderoi,* an extra seta being found between seta "4" in the anterior and posterior rows (and one more, "3a" in the posterior row), t XI has only four setae, the median pair being missing.

Lectotype: "Mature female under rotten bark, Blaise Castle, Bristol, 27/12/26, H. Womersley" in the collection of the South Australian Museum, Adelaide.

9. **Acerentomon nemorale** Womersley

Acerentomon nemorale Womersley 1927a p. 142, fig. 2.

Fig. 38-44.

This species, which with its 2 mm. length is among the largest Proturans known, was described from "one of two specimens taken in the rotten sapwood of an old stump in Brockley Combe, Somerset, 17.IV.1926". There is only one slide present in the collection, most probably a female though some impurities prevent a clear decision, with the date and locality as in the description. It is marked "Type" and may be regarded as the holotype, though Womersley expressly states, "genital organs well developed".

The foretarsus (fig. 38-39) of which only one leg is present has been examined and drawn from both the exterior and interior sides. Unfortunately some of the setae have been more or less broken off, a transverse line in the drawings indicates where they are broken; t1 is only represented by the socket so that it cannot be stated whether it is claviform, although it is most probably so, t2 is slender and curved and t3 is long lancet-like. The most characteristic feature is the short and slender sensilla b, shorter and not broader than c. The other

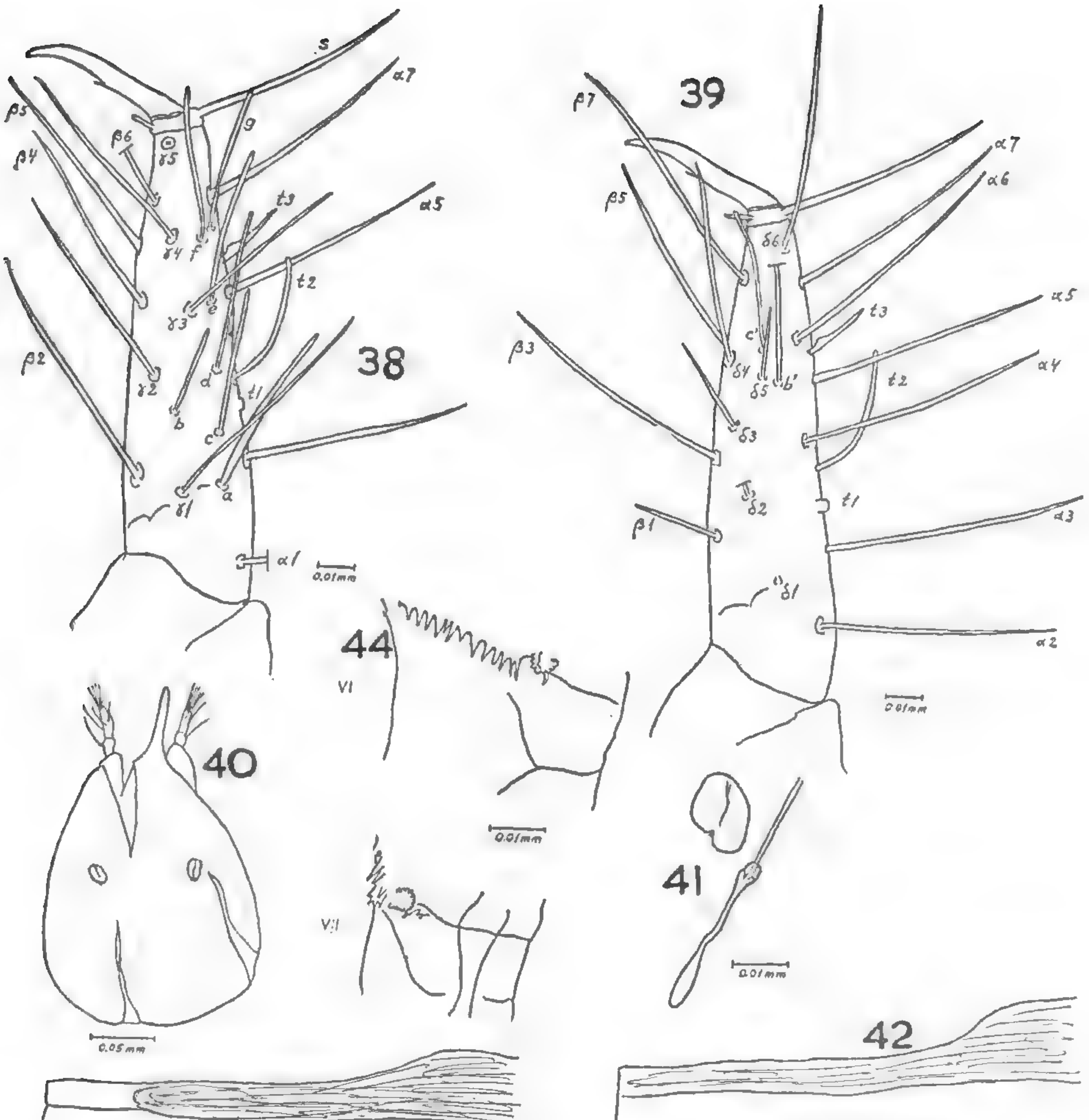

Fig. 38-44. *Acerentomon nemorale* Wom.; Holotype ♀. 38, foretarsus, exterior side; 39, interior side of same; 40, contour of head; 41, pseudoculus and filamento di sostegno; 42, comb of abd. VIII; 43, pleurite VIII and part of sternite; 44, pleural pectines on abd. VI and VII, sternum to left.

sensillae are long, a stouter than the others, e in the middle between d and f; a′ is missing, b′ near to c′ with δ 5 between them, s long and straight. TR = 3.0, e:u = 7:45.

The head as shown in fig. 40, a little crushed. LR = 4.2 (Womersley has 2.8). The filamento di sostegno (fig. 41) with longer proximal part than in *bagnalli.* The comb on abd. VIII (fig. 42) is very characteristic with 9-10 strong and long teeth set apart, the most lateral one recurved against the others, the next two the longest, and numbers 6 and 8-10 equally long but diverging from the small number 7. A row of small blunt teeth is found near the striated line on the anterior part of the segment, and also ventrally. The eighth pleurite has 6-7 small blunt teeth along the hind margin (fig. 43).

The pectine on pleurite VI with about 15 long teeth and one or two more near the "rotary-wheel". Pleurite VII with a few sharp and slender teeth lateral to this wheel and two groups of stouter ones on the median side (fig. 44).

The chaetotaxy is as follows:

	I	II-III	IV	V-VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{14}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{8}{13}$	14	10	6	9
s	$\frac{3}{4}$	$\frac{5}{5}$	$\frac{6}{8}$	$\frac{7}{8}$	$\frac{5}{9}$	$\frac{4}{2}$	4	4	6	6

The number of 6 setae in the anterior row of s IV is certainly an abnormality, although they are arranged symmetrically.

In t VII seta "1" is missing in the anterior row but a seta is present between number "4" in the anterior and posterior rows; in both characters it is distinguishable from the preceding segments.

The short and slender sensilla b of the foretarsus and the shape of the abdominal combs make this species clearly distinguishable. Unfortunately fig. 2 of Womersley is not correct in details of the pectines. The species has since been recorded by Condé (1944 p. 44) from France, and by Nosek (1957) and Paclt (1958) from Czechoslovakia. The last two authors, however, do not agree as to which species should be called *nemorale*; some specimens lent to me by Dr. J. Nosek, Bratislava, show that at least his species is another species which he is going to describe. Condé has seen that Womersley's pectine on abd. V in fact belongs to abd. VI and he also notes that the chaetotaxy of sternites II-IV "sont sujets à variations".

Holotype: Female(?) "under bark, Brockley Combe, Som. 17/4/26, H. Womersley" in the collection of the South Australian Museum, Adelaide.

10. **Acerentomon oblongum** Womersley

Acerentomon oblongum Womersley 1927a p. 143, fig. 3.

Fig. 45-52.

Womersley described this species from two specimens "received from Mr. Bagnall, labelled Sta. Banks, Whitby, and Fencehouses". This species is not present in Womersley's collection in Adelaide, but a slide containing a specimen determined as this species and marked "Type" has recently come to the British Museum (Nat. Hist.), London, with the collection of R. S. Bagnall. It is furthermore labelled "Whitby, Sta. Bks" and must therefore be one of the two specimens mentioned by Womersley; I therefore select it as a lectotype and describe it as follows:

The foretarsus (fig. 45-46) is characterised by a long and extremely slender claw. Unfortunately many of the setae are broken, and in the figures, where it is not possible to complete from the other foretarsus this is indicated by a transverse line. Sensilla b is a little broader than the others which are all rather long and almost equally so, e is situated much nearer to d than to f, t1 is rather long and claviform, t3 lancet-like and not extremely long. The interior side is characterised by an extremely long δ 4. TR = 2.5 (Womersley gives 1.6, but his figures "front tarsus 101μ, claw 45μ" give 2.2), e:u = 10:67.

The head (fig. 47), upon which the specific name is based is of quite different shape to that of other species of *Acerentomon*. It is broken in the mid-line as shown in the figure, but its long and narrow shape is obvious. The rostrum is long, exceeding the maxillary palpi, but LR amounts to only 4.7. The shape of the pseudoculus is shown more enlarged; it shows a small but distinct sort of "handle" or "lever". The filamento di sostegno could not be seen.

The comb of abd. VIII (fig. 48) consists of 14 teeth, the four median ones being shorter and more dispersed than the laterals. The anterior part of this segment carries only a few very small dispersed teeth. The pleurite has 4-5 small blunt teeth on the hind border (fig. 49). Pleurite VII with two stout and two fine teeth, pl. VI with a row of about 7 rather long and acute teeth (fig. 50).

The chaetotaxy is not easy to follow, as the anterior part of the body is twisted and the four posterior segments so much withdrawn

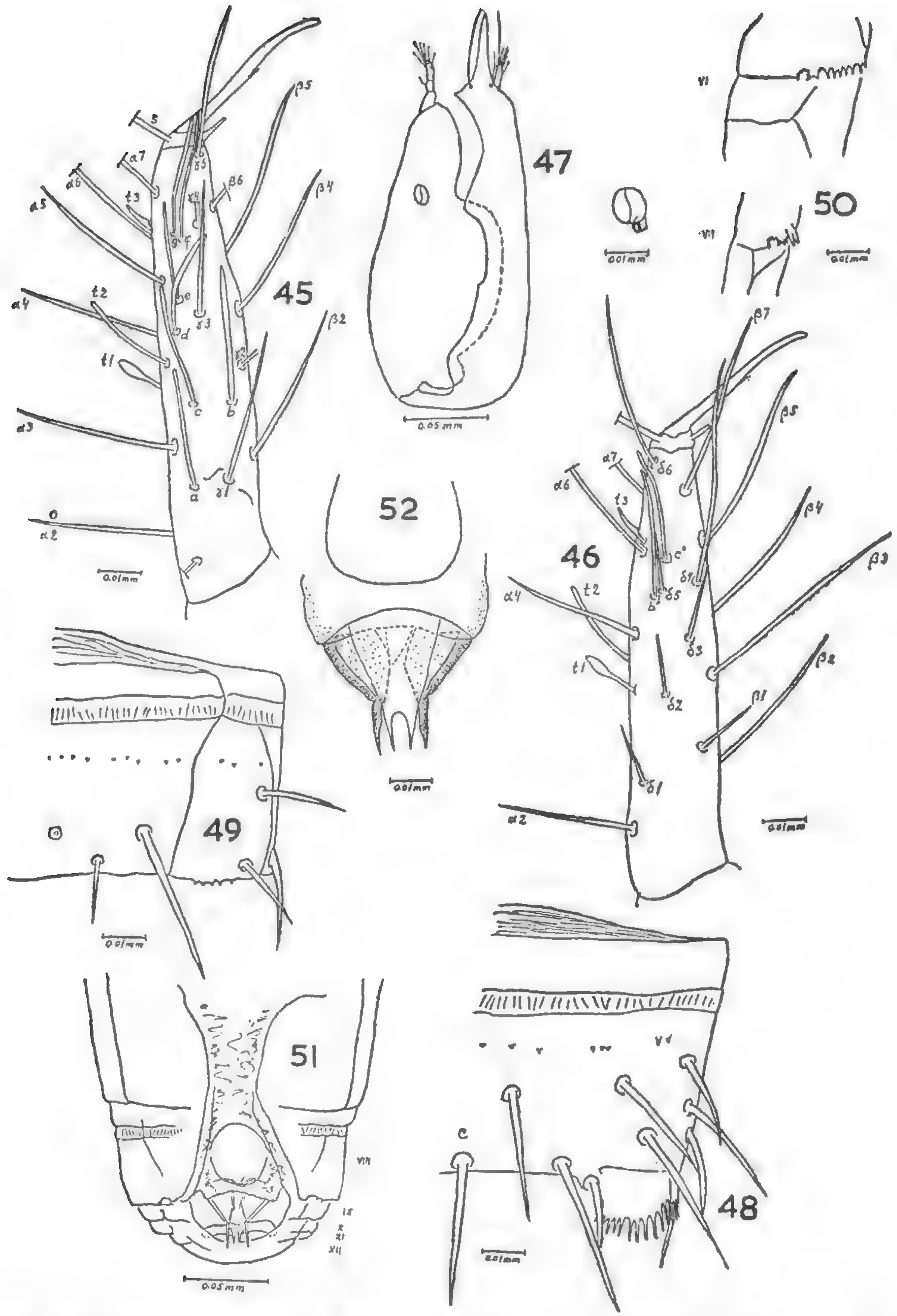

Fig. 45-52. *Acerentomon oblongum* Wom.; Lectotype ♀. 45, foretarsus exterior side; 46, interior side of same; 47, contour of head, to the side a pseudoculus; 48, comb of abd. VIII; 49, pleurite and half of sternite of abd. VIII; 50, pectines of pleurites of abd. VI and VII, sternum to right; 51, genital squama from venter and *in situ*; 52, same, more enlarged.

into abd. VIII that their setae are hardly distinguishable. It may be given as follows:

	I	II	III	IV-VI	VII	VIII	IX	X	XI	XII
t	?	?	$\frac{10?}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{8}{13}$	14	12?	?	9
s	?	?	$\frac{7}{5}$	$\frac{7}{8}$	$\frac{5}{0}$	$\frac{4}{2}$	4	4	?	6

The most curious feature of the whole animal, however, is the genital squama, if I identify it correctly. The specimen unfortunately is not cleared as much as could be wished, and the characters of the last segments are obscured by their contraction. Fig. 51 gives a sketch of the genital squama *in situ*, and fig. 52 of the squama itself more magnified. It looks as if two sclerotised rods connect the basis of tergite VII with the pectinal parts of tergite VIII but proximally these rods seem to be fused in the middle, and the whole structure may also be interpreted as an "endosternum", a view which seems to be supported by its finer structure. Distally a structure of loose contour appears to connect the "rods" and from this extends what I presume to be the real squama genitalis, corresponding to the distal part of the common squama. It consists of an acrogynium(?) and two acrostyli, ending in a seta or cannula. Between these acrostyli two more styli are found, but their connections to the other parts I am unable to follow, nor can I see the true opening of the vagina—if it is at all a female squama. The acrostyli are covered dorsally by two weakly chitinised "wings" and the whole squama is situated in a "cave" opening in the usual way. I have only seen the type specimen and as the species has not been recorded since the original description I am unable to investigate it further. I hope, however, that the species may be rediscovered, and that then, some one from the above indications, may get enough material to solve the problem.

Lectotype: Female(?) marked "Whitby Sta. Bks., R. S. Bagnall" in the British Museum (Nat. Hist.), London.

11. **Acerentomon metarhinus** Womersley

Acerentomon metarhinus Womersley 1928a p. 113.

Fig. 53-57.

This species was described from a single specimen "from amongst tangled bracken roots under a stone in Cranham Woods, Glos., 13/9/26". Womersley reported the specimen to be of the eleven-segmented instar: in earlier papers (1949, 1956a) I have shown that the instar does not exist, and the specimen in question rightly appeared to be a maturus junior (see fig. 57). Because of this the chaetotaxy is not to be relied upon; on the other hand Womersley is right in stating that the characters LR and TR are constant throughout the larval life, and this holds good also for the further characters of the foretarsus (see Tuxen 1949 where it is also shown that all these characters are different in the prelarva, not known to Womersley). I give a description of the characters seen on the specimen, which unfortunately is crushed and difficult to examine.

The foretarsus (fig. 53-54) (only the left one is present) is rather short and broad. It is characterised by sensilla b being slender, and e placed much nearer to d than to f, t1 is slenderly claviform, t3 short but slender. TR = 2.7 (Womersley gives 3.0), e:u = 6:52.

The head is very squashed; fig. 55 gives its rough outline but the hind border is difficult to ascertain. LR is given as 6.4, to me it seems more like 6.0. The pseudoculi are as figured, the filamento di sostegno could not be seen.

The comb on abd. VIII (fig. 56) carries about 14 slender but rather short teeth of which the middle ones are the longest, decreasing slowly in length to both sides. The hind border of the pleurite carries four very short and fine teeth, but there are only a few short and dispersed teeth on the anterior part of the segment. The pectines on pleurites VI and VII, if any, could not be seen.

The chaetotaxy (fig. 56) could not be seen on the first four abdominal segments; on abd. V-XII it is as follows:

	V-VII	VIII	IX	X	XI	XII
t	$\frac{10}{16}$	$\frac{8}{13}$	12	8	4	9
s	$\frac{5}{8}$	4	4	4	2	6

but it must be remembered that the specimen is a maturus junior, which is further shown by the presence of only two setae on the sternum XI (see Tuxen 1949 p. 28).

It will be seen that there are only very few really characteristic features present, among them being the slender sensilla b, and the position of e on the foretarsus, and especially the shape of the comb on VIII. Nevertheless both Ionescu (1932) and Condé (1944) mention this species from Roumania and France, respectively. I do not know

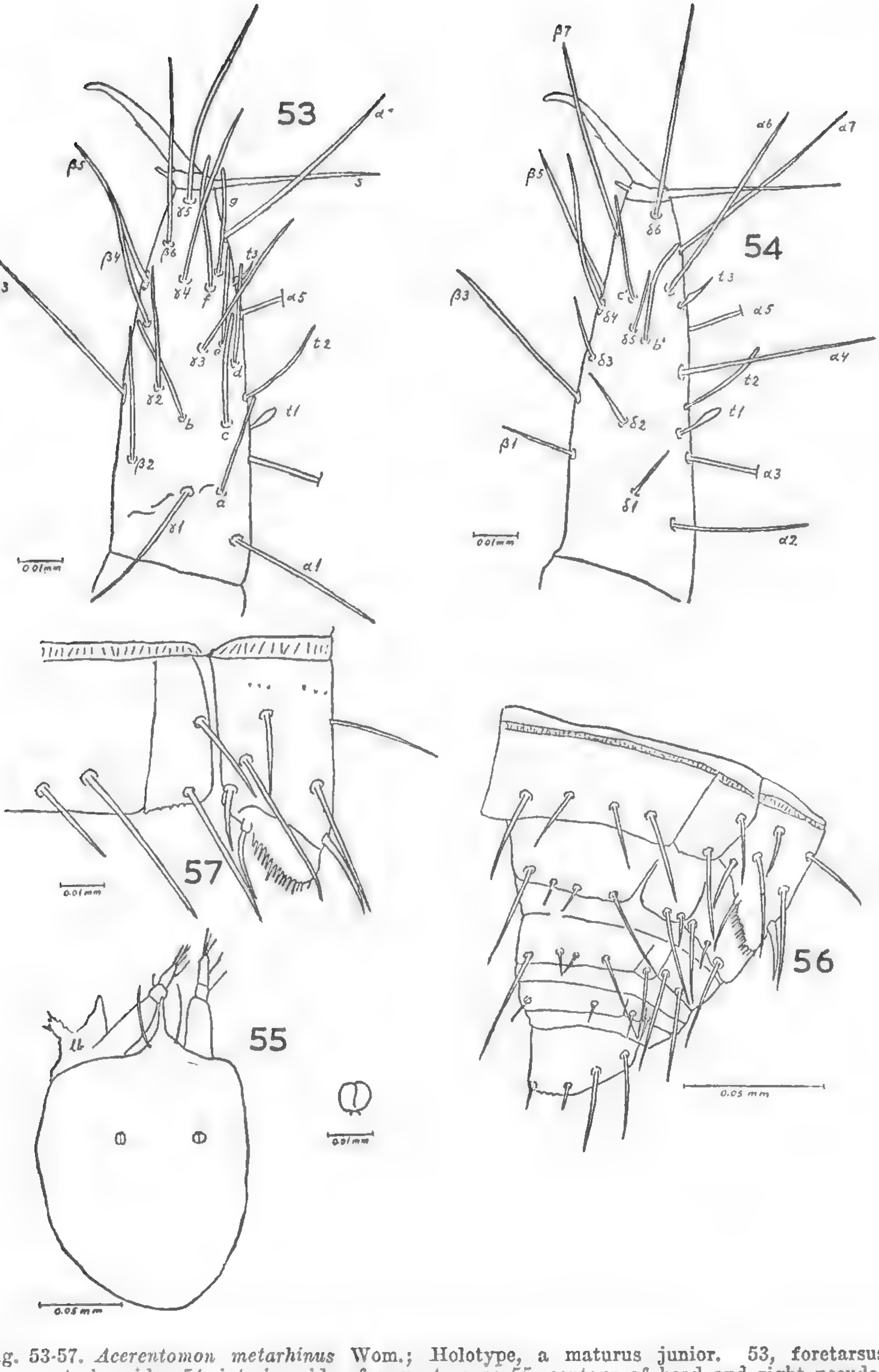

Fig. 53-57. *Acerentomon metarhinus* Wom.; Holotype, a maturus junior. 53, foretarsus exterior side; 54, interior side of same tarsus; 55, contour of head and right pseudoculus; 56, chaetotaxy of abd. VIII-XII; 57, comb of abd. VIII.

on what characters these determinations are founded; both authors only give the length in μ of some parts of the body, appendages or setae, but these measurements are often not the same as given by Womersley and even not the same between the two authors. For instance: TR = 2.6 (Condé), 2.75 and 2.55 (Ionescu), 3.0 (Womersley)—and 2.7 for my measurement of the holotype; or length of rostrum 25μ (Condé, Ionescu, in adult individuals), 27μ (Womersley in the maturus junior). It is therefore, not quite certain that the reports of this species from France and Roumania are correct; the species was not present in that portion of Ionescu's collection which I have had before me (Tuxen 1961). Condé mentions a line of teeth on both tergite V and VI, but I have not been able to see these pectines on the holotype; maybe they are not present in the maturus junior.

Holotype: A maturus junior from "Cranham, Glos., 13/9/26, H. Womersley" in the collection of the South Australian Museum, Adelaide.

12. Acerentomon agrorum Womersley

Acerentomon agrorum Womersley 1928a p. 114.

This species was described from a "single specimen from under stone along with *Acerentulus confinis* Berlese, Brockley Combe, Somerset, October, 1926". In Womersley's collection, specimens of *A. confinis* from the above locality are present, but on none of the slides could any *Acerentomon* be found and no slide of *agrorum* is present; nor in the collection of Bagnall is there any specimen bearing the name *A. agrorum*. It must, therefore, be concluded that the single specimen, the holotype, has been lost.

From the description alone, the species cannot be identified. Apart from some measurements only three characters are given by Womersley: LR = 4.1, TR = 2... (but his figures give 2.5), and spines on the eighth tergal pectine of equal length. These characters, however, are too insignificant to make a characterisation of the species possible, and nobody has found specimens since then; and furthermore the description was made on an immature specimen (called the eleven-segmented instar, which means maturus junior). It seems therefore advisable to abandon this species altogether from future catalogues.

13. **Acerentomon pinus** Womersley

Acerentomon pinus Womersley 1928a p. 114.

Fig. 58-62.

This species too, was described from a maturus junior (Womersley says a specimen of the "eleven segmented instar" but the limit between the eleventh segment and the end segment is very distinct) "under bark of an old pine stump, Brockenhurst, New Forest, 24/5/26"; and only this specimen is so far known. It is not very well mounted, not all the characters being distinguishable. It will be described as follows:

The foretarsus (fig. 58-59) is characterised by a very long sensilla a which is somewhat thicker than the other sensillae, b is relatively short and slender, c long and placed nearer to d than to f, t1 is relatively long with a slender club, t3 short but slender. All the setae are very long, especially conspicuous being the γ setae. TR = 2.7 (Womersley gives 2.6), e:u = 6:53.

The shape of the head is shown in fig. 60, LR = 3.3. The filamento di sostegno cannot be seen.

The comb on abd. VIII (fig. 61) has 12 relatively short but slender teeth. A row of very dispersed and very small teeth on the anterior part of the segment. The hind border of pleurite VIII (fig. 62) with three short teeth. Pectines on pleurite VI and VII not visible, either missing or too hyaline to be seen.

The chaetotaxy on the first three abdominal segments cannot be seen as the specimen is coiled in the slide. For the rest it is as follows:

	IV-VI	VII	VIII	IX	X	XI	XII
t	$\frac{10}{16}$	$\frac{10}{17}$	$\frac{8}{13}$	12	8	6	9
s	$\frac{5}{8}$	$\frac{4^{(13)}}{8}$	4	4	4	2	6

The number of 2 setae on s XI shows the specimen to be a maturus junior (see above).

Holotype: A maturus junior from "Brockenhurst, 24/5/26. H. Womersley" in the collection of the South Australian Museum, Adelaide.

(13) Abnormal, one of the setae being placed in the middle line.

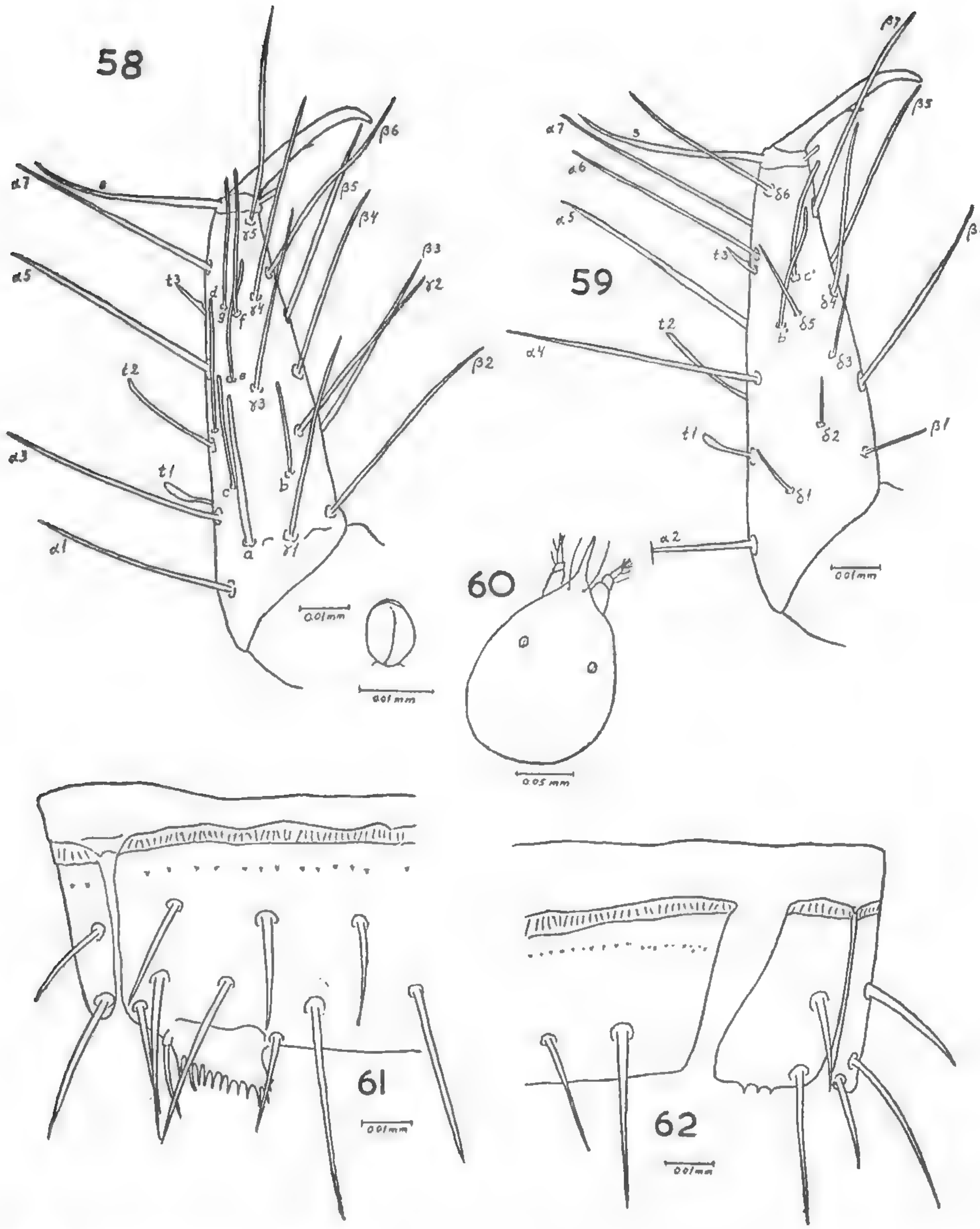

Fig. 58-62. *Acerentomon pinus* Wom.; Holotype, a maturus junior. 58, foretarsus exterior side; 59, interior side of same tarsus; 60, contour of head and a pseudoculus; 61, comb of abd. VIII; 62, pleurite and half of sternite VIII.

14. Acerentulus capensis Womersley

Acerentulus capensis Womersley 1931 p. 89, fig. 1-2.

Fig. 63-69.

This is the first species of *Acerentulus* to be described by Womersley, based on two specimens collected at Cape Town, S. Africa, on his way to Australia. The two specimens in the South African Museum have been kindly lent to me by Dr. A. J. Hesse. One specimen is a female but unfortunately all six legs are missing, the other is a maturus junior. As the characters of the foretarsus are of such paramount importance in *Acerentulus* and alike in all stages except the prelarva, I am forced to make the maturus junior the lectotype describing it as follows; the chaetotaxy, however, will be given from the female. Both specimens are labelled "Orangezicht, Cape Town, 6/9/30. H.W.".

The foretarsus (fig. 63-64) is first and foremost characterised by the large bottle-shaped sensilla a′ which I have not seen in any other species of *Acerentulus*, t1 is club-shaped, t2 long and slender, t3 small and not lancet-like but long-oval without pointed apex (also a distinguishing character from other *Acerentulus* species), a-d and f are all equally long and slender, e and g shorter, e is placed nearer to f than to d, b is a little stouter than the other ones. On the inner side b′ is missing, c′ long and slender. TR = 3.3, e:u = 1:7.

The filamento di sostegno (fig. 65) is rather short, not reaching the tip of the inner arm of the fulcrum. The comb of abd. VIII (fig. 66) consists of six short teeth.

The chaetotaxy of the female (fig. 67-69) is as follows with the pleural setae included in the tergal counts.

	I	II-III	IV-V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{12}$	$\frac{8}{14}$	$\frac{8}{14}$	$\frac{10}{14}$	$\frac{6^{(14)}}{16}$	$\frac{6}{14}$	14	12	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	4	4	4	6	6

I have figured the whole tergal chaetotaxy of the abdomen to show a curious feature. In the anterior row "3" is placed further back than the other setae. In abd. VI this is even more pronounced and in VII the seta has retreated right back into the posterior row. This retreating of "3" of the anterior row is met with, more or less pronounced, in many Protura. The striated band which occurs in all

(14) "1" is missing.

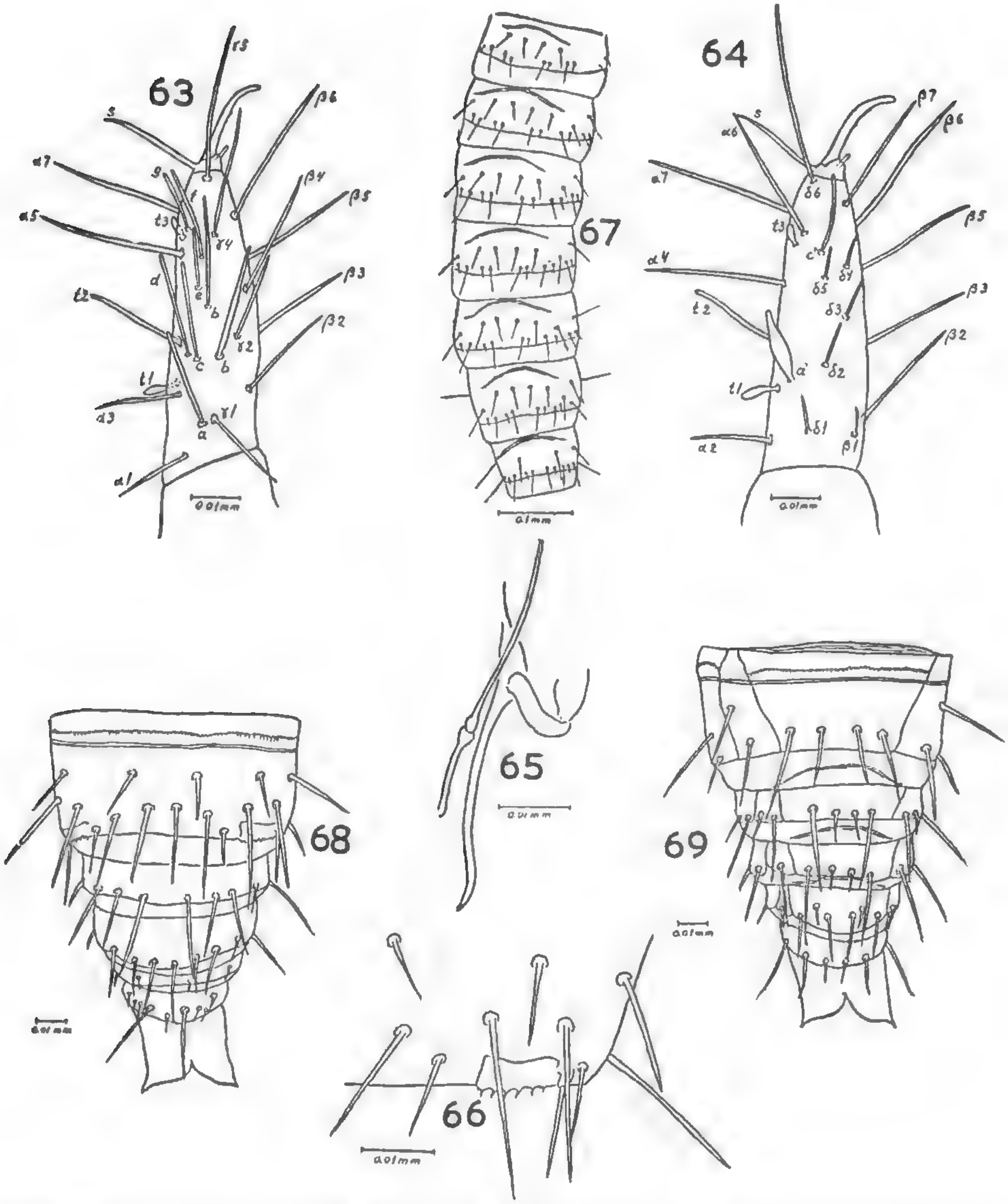

Fig. 63-69. *Acerentulus capensis* Wom. 63, 64 and 66 from lectotype, a maturus junior, 65, 67, 69 from a ♀. 63, foretarsus exterior side; 64, interior side of same; 65, filamento di sostegno; 66, comb of abd. VIII; 67, tergal chaetotaxy of abd. I-VII; 68, same of abd. VIII-XII; 69, sternal chaetotaxy of abd. VIII-XII.

Acerentominae on the anterior part of the eighth abdominal segment has a curious appearance in this species. The striae are almost entirely invisible; instead the anterior border consists of a row of very fine teeth, shorter or longer, and the posterior border of two exactly parallel lines (fig. 68-69). I have unfortunately only observed it in this one specimen but may be the clue to what this striated band really is lies hidden in this species.

The species is easily distinguished on the shape of a′ in the foretarsus.

Lectotype: A maturus junior from "Orangezicht, Cape Town, 6/9/30. H. Womersley" in the South African Museum, Cape Town.

15. **Acerentulus westraliensis** Womersley

Acerentulus westraliensis Womersley 1932 p. 71, fig. 9-12; 1939 p. 286, fig. 78 E-H.

Fig. 70-75.

The description and drawings of this species were repeated unchanged in the 1939 publication. Several slides are present in the collection and I have chosen a male from Crawley, Western Australia, as a lectotype which is described as follows:

The foretarsus (fig. 70-71) has very long and slender sensillae a-g, a is a little stouter than the others, e is placed quite near f, and b, c, and d are not in a line, t1 is slender and club-shaped, t2 long and slender, t3 short-oval and not lancet-like. On the inner side a′ is long and thick, b′ and c′ long and slender. TR = 3.5, e:u = 1:8.

The filamento di sostegno (fig. 72) is rather long and most unusually the posterior end seems to be shortly three-lobed.

The comb on abd. VIII (fig. 73) consists of five slender dispersed teeth.

The chaetotaxy (fig. 74-75) is as follows:

	I	II	III	IV-V	VI	VII	VIII	IX	X	XI	XII
t	6/12	8[15]/14	8/14	8/14	10/14	8[17]/16	6/14	14	12	6	9
s	3/4	2[16]/5	3/5	3/8	3/8	3/8	4[18]	4	4	6	6

Lectotype: A male from "Crawley W.A., 8/5/31, D. C. Swan", in the South Australian Museum, Adelaide.

(15) "5" is missing; (16) but normally 3; (17) "3" in anterior row, retreated to posterior row; (18) normally in a row.

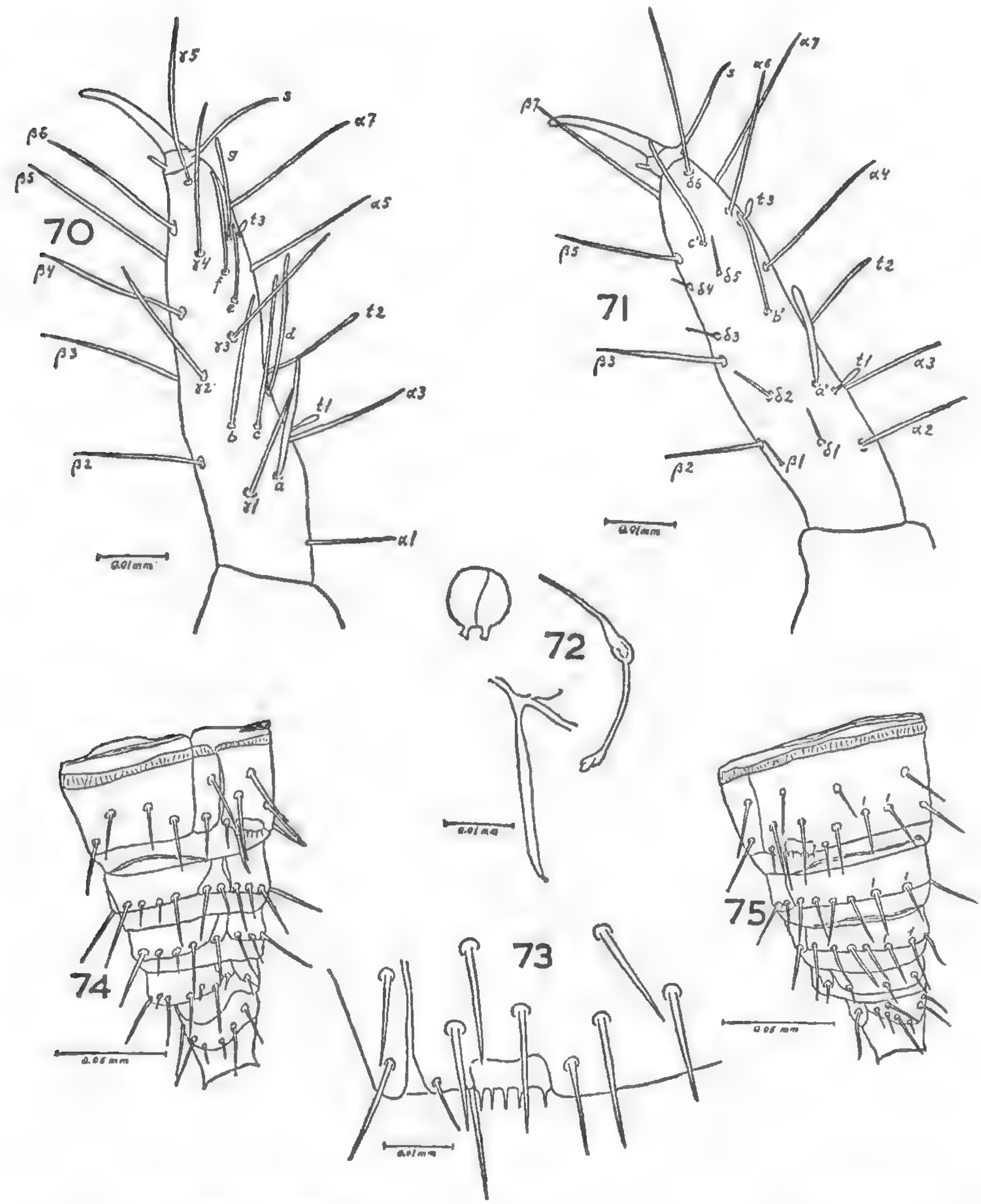

Fig. 70-75. *Acerentulus westraliensis* Wom.; Lectotype ♂. 70, foretarsus exterior side; 71, interior side of same; 72, filamento di sostegno and pseudoculus; 73, comb of abd. VIII; 74, tergal chaetotaxy abd. VIII-XII; 75, sternal chaetotaxy abd. VIII-XII.

16. **Acerentulus australiensis** Womersley

Acerentulus australiensis Womersley 1932 p. 72, fig. 3, 11-12; 1939 p. 284, fig. 78 1-L.

Fig. 76-80.

This species is said to have been found "on only one occasion" which seems to imply only one specimen as only one slide with a male, from "Crawley, W.A. 30/10/30. D. C. S." is present in the collection exactly as stated in the description, repeated unchanged in 1939. Both foretarsi (fig. 76) are seen directly from above, but only one is drawn. It is seen to be very close to that of *westraliensis* in the length and position of the sensillae. TR = 3.9, e:u = 1:6.

The filamento di sostegno (fig. 77) is three-lobed at the proximal end and does not exceed the proximal arm of the fulcrum.

The comb of abd. VIII (fig. 78) with 8 very small teeth.

The chaetotaxy (fig. 79-80) is as follows:

	I	II-III	IV-V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{10}$	$\frac{8}{10}$	$\frac{8}{10}$	$\frac{10}{10}$	$\frac{8}{16}$	$\frac{6}{14}$	14	12	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	3	4	4	6	6

The difference which Womersley notes is that sternite VIII has only three setae. This is quite unusual and may be due to individual variation but another difference is that "1a" and "4a" are missing in all posterior rows of tergites I-VI (fig. 79).

The species was founded on only a single specimen from the same locality (University Grounds, Crawley, Western Australia) as the 6 specimens of *westraliensis* on which the description of the latter species was based. Only the specimen of *australiensis* was collected on October 30th, 1930, the other specimens on November 2nd, 1930, and April-July, 1931, all by Mr. D. C. Swan. I would be tempted to synonymise the two species as all characters except the chaetotaxy are alike, and I would not hesitate to regard the chaetotaxy of sternite VIII as an abnormality, but I have not known earlier examples of the missing of the accessory hairs in the posterior tergal rows being due to individual variation. It might be a pre-imago ♂ (in *A. danicus* Condé, "1a" is missing in the posterior tergal rows in this stage), but the genital squama is distinct and fully developed. Also the comb of abd. VIII is different from that of *westraliensis*.

Holotype: A male from "Crawley, W.A., 30/10/30. D. C. Swan" in the South Australian Museum, Adelaide.

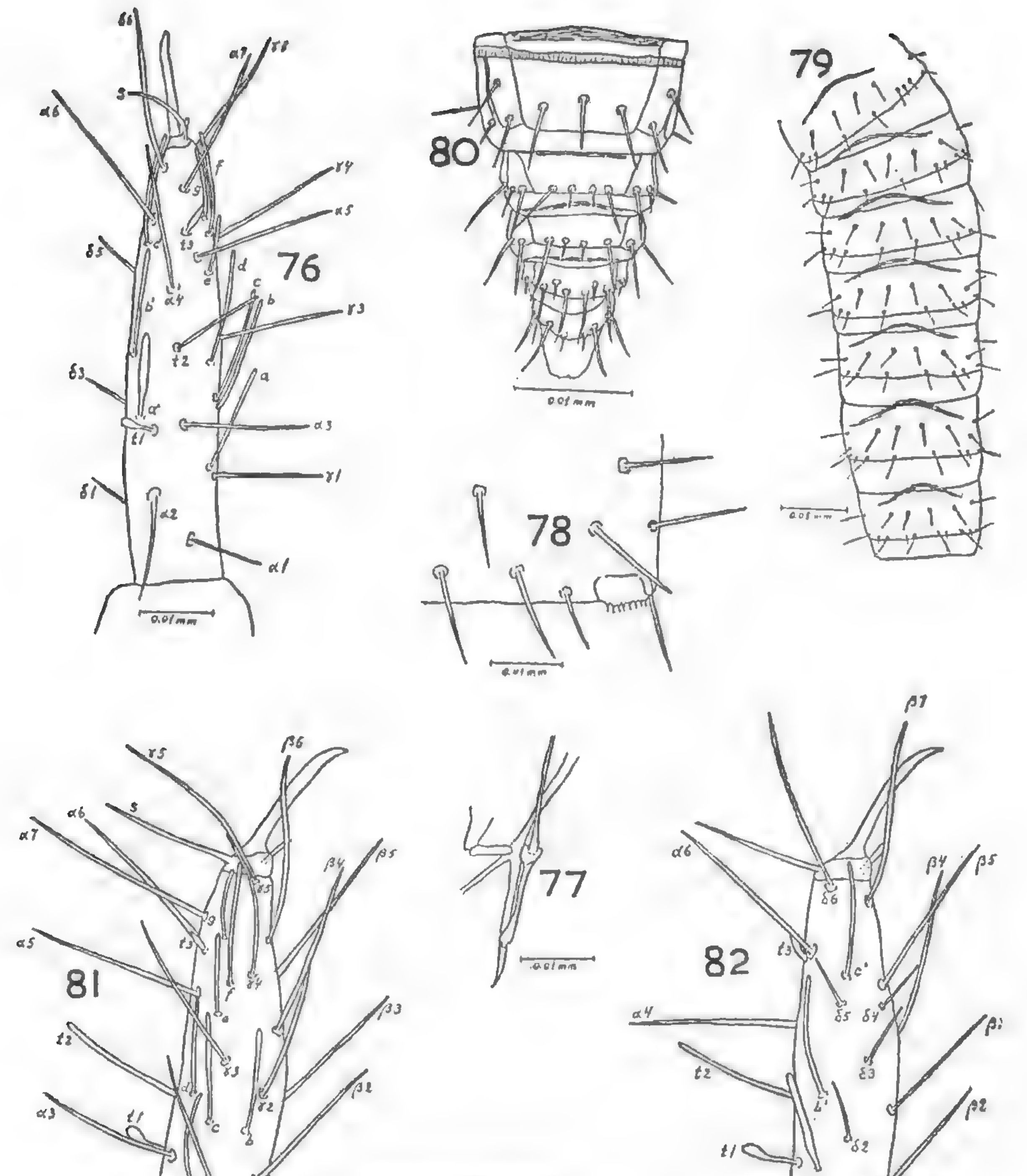

Fig. 76-80. *Acerentulus australiensis* Wom.; Holotype ♂. 76, foretarsus from above; 77, filamento di sostegno; 78, comb of abd. VIII; 79, tergal chaetotaxy of abd. I-VII; 80, sternal chaetotaxy of abd. VIII-XII.

Fig. 81-83. *Acerentulus tillyardi* Wom.; Lectotype ♀. 81, foretarsus, exterior side; 82, interior side of same; 83, comb of abd. VIII.

17. **Acerentulus tillyardi** Womersley

Acerentulus tillyardi Womersley 1932 p. 73, fig. 1, 2, 13, 14; 1939 p. 284, fig. 77 A-F.

Fig. 81-83.

Womersley writes that this is the only species found in the Eastern Australian States. It was first found by Dr. R. J. Tillyard at Blundells', F.C.T., 18th February, 1931, but only one specimen which now appears to be lost. Several other specimens were found the same year at Belgrave, Victoria, on the 19th April. Of these, two slides are present in Womersley's collection, one a pre-larva, the other a female; I select the latter as a lectotype. Several other slides are also present, found after the publication of the original description, and some of these are referred to in 1939.

Womersley says that the species is very similar to *A. westraliensis* but differs distinctly in the value of TR which he gives as 3.5 in *westraliensis* and 3.0 in *tillyardi*. This, however, is the only difference he gives.

I have examined and drawn the lectotype though its state of preservation does not permit me to see the characters of the foretarsus and the pseudoculi as clearly as in other species, nor can the filamento di sostegno be seen at all. I give the drawings of the foretarsus (fig. 81-82) with the sensillae as clearly as possible but my conclusion is that the small differences from the two preceding species are due only to my difficulty in examination. TR = 3.0, e:u = 1:6.

The comb of the eighth abdominal tergite (fig. 83) has six dispersed teeth as in *westraliensis,* but they are extremely short as in *australiensis.*

The chaetotaxy is exactly as in *australiensis,* except that s VIII = 4.

Lectotype: A female from "Belgrave (Victoria) 19/4/31, coll. F. H. Drummond" in the South Australian Museum.

The preceding three species of *Acerentulus* seem to me to be very close to one another—if they are really different. The foretarsi are very much alike as to size and disposition of the sensillae. The ratio TR, however, varies in the three type specimens. The filamento di sostegno is three-lobed proximally in two of them and possibly also in *tillyardi* (could not be seen). The abd. comb VIII consists of 6 longer teeth in *westraliensis,* 8 short ones in *australiensis* and 6 short ones in *tillyardi,* and in all three species dispersely set. The chaetotaxy differs in so far as "1a" in the posterior row of the abdominal segments is missing in *australiensis* and *tillyardi* (s VIII = 3 in *australiensis* may be regarded as abnormal). I have examined the other specimens found after the publication of the original description and find that one is a true *westraliensis,* the others are like *westraliensis* but with the chaetotaxy as in *tillyardi.*

18. **Acerentulus occidentalis** Womersley

Acerentulus occidentalis Womersley 1932 p. 73, fig. 15-16; 1939 p. 285, fig. 78 A-P.

Fig. 84-90.

This species was described in 1932 (repeated unchanged in 1939) from seven specimens, two from the "University Grounds, Crawley, W.A. 28/4/31 and 29/6/31", and five specimens from "Fairbridge Farm, Pinjarra, W.A. 20/9/31, under stones", all collected by Mr. D. C. Swan. Two slides are present in the collection of which I select a female as the lectotype described as follows:

The foretarsus (fig. 84-85) is very much like that of the preceding species, t1 slenderly club-shaped, t3 not lancet-like, b shorter than c, e placed very near to f, a′ is thicker than all the other sensillae. TR = 4.0, e:m = 1:8.

The filamento di sostegno (fig. 86) is longer than the arm of the fulcrum, and weakly three-lobed at the proximal end. The shape of the head is seen in fig. 87; there is a distinct labrum. Abdominal comb VIII (fig. 88) has 15 very closely set and rather long teeth.

The chaetotaxy is as follows (fig. 89):

	I	II-III	IV-V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{12}$	$\frac{8}{14}$	$\frac{8}{14}$	$\frac{10}{14}$	$\frac{8}{16}$	$\frac{6}{14}$	14	12	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{2}{2}$	4	4	6	6

This is exactly as in *westraliensis* except that the two median setae on sternite VIII are placed in an anterior row. The tergal apodemes are slightly branched.

Lectotype: A female from "Crawley, W.A. 21/4/31, coll. D. C. Swan", in the South Australian Museum, Adelaide.

This species is distinctly different from the three preceding species but the great resemblance in the foretarsus is very curious. The

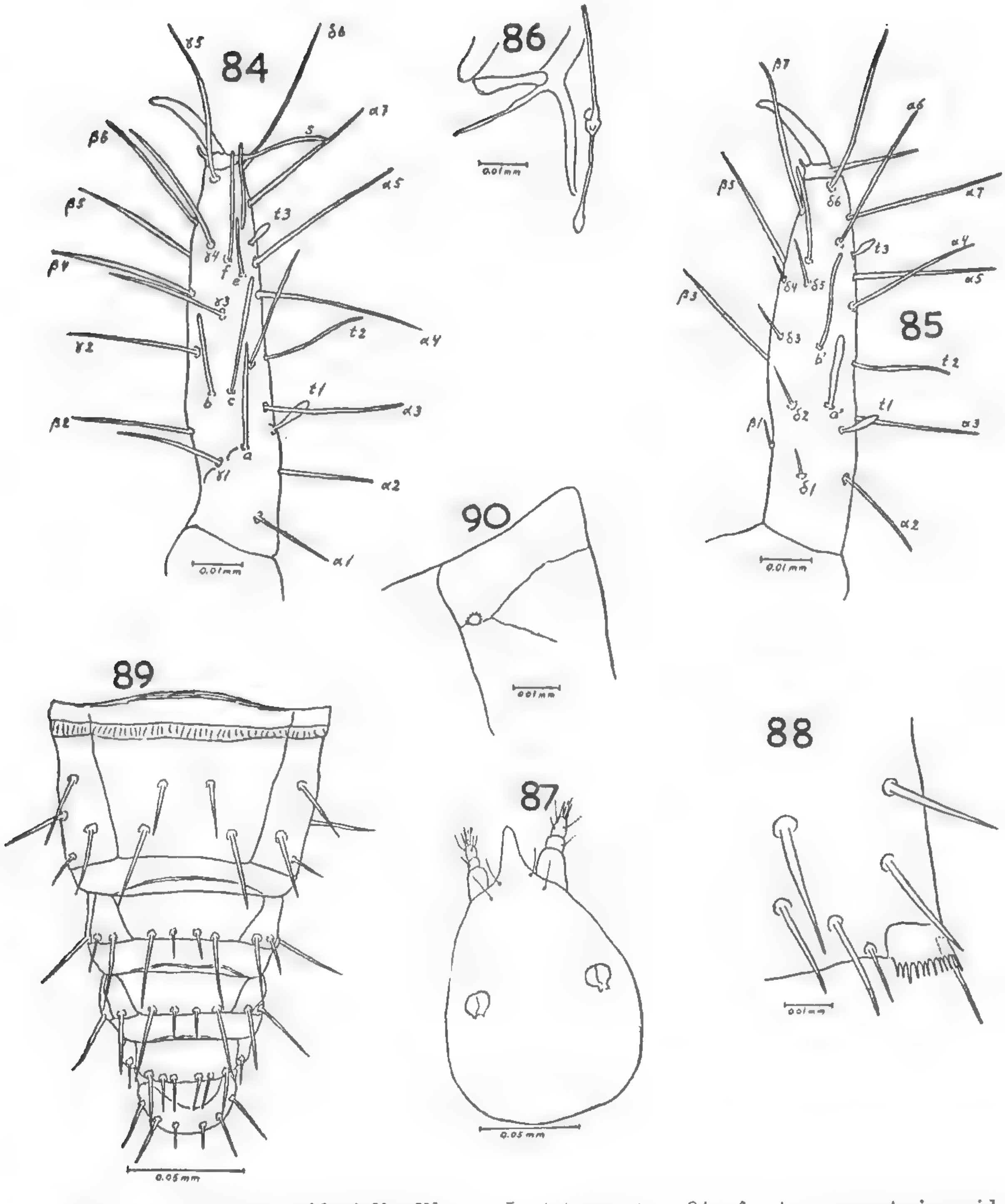

Fig. 84-90. *Acerentulus occidentalis* Wom.; Lectotype ♀. 84, foretarsus, exterior side; 85, interior side of same; 86, filamento di sostegno; 87, contour of head; 88, comb of abd. VIII; 89, sternal chaetotaxy of abd. VIII-XII; 90, anterior part of pleurite VII, sternum to left.

abd. comb VIII, however, distinguishes it clearly as also does the disposition of the sternal setae on abd. VIII. The presence of a labrum is quite unexpected. With uncertainty as to the real difference between *Acerentulus* and *Acerentomon* I should not like to transfer the species to the latter genus: firstly because of the great similarity of the foretarsus and the filamento di sostegno to the *Acerentulus* species, and secondly because it shows no pleural row of teeth on abd. VIII as species of *Acerentomon* generally do, nor is there a pectine on pleurite VI or VII. The only feature reminiscent of this is the "rotary-wheel" which is present on pleurite VII (fig. 90) and which I have not observed in the preceding *Acerentulus* species.

19. **Acerentulus sexspinatus** Womersley

Acerentulus sexspinatus Womersley 1936 p. 65, fig. 1-2; 1939 p. 286.

Fig. 91-98.

This species was described in 1936 from a number of specimens collected by Mr. D. C. Swan from under stones "on banks of the River Onkaparinga, near Noarlunga, South Australia, April 25th, 1932". Later, Womersley collected two adult and five immature specimens from under stones on the banks of the stream in the Bolganup Ravine, South Western Australia, 30/9-1/10/32. Slides of these specimens are not present in Womersley's collection. The description was repeated in 1939.

As justified in the introduction I select one of the original collection, marked as "type" as a lectotype and describe it as follows:

The foretarsus (fig. 91-92) is provided with very long and slender sensillae, only a′ being stout but long, t1 is slenderly club-shaped, t3 long and lancet-like. TR = 6.0, e:m = 1:7.

The filamento di sostegno (fig. 93) is as long as the proximal arm of the fulcrum; its proximal end two-lobed, heart-shaped. Fig. 94 shows the shape of the head and the exceptionally broad pseudoculi.

The comb of Abd. VIII (fig. 95) with about 10 closely set teeth.

The chaetotaxy (fig. 96-98) is as follows:

	I	II-III	IV-V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{10}$	$\frac{8}{12}$(19)	$\frac{8}{12}$	$\frac{8}{14}$	$\frac{8}{18}$	$\frac{6}{16}$	12	12	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{4}{2}$	4	4	6	6

(19) "1a" is missing.

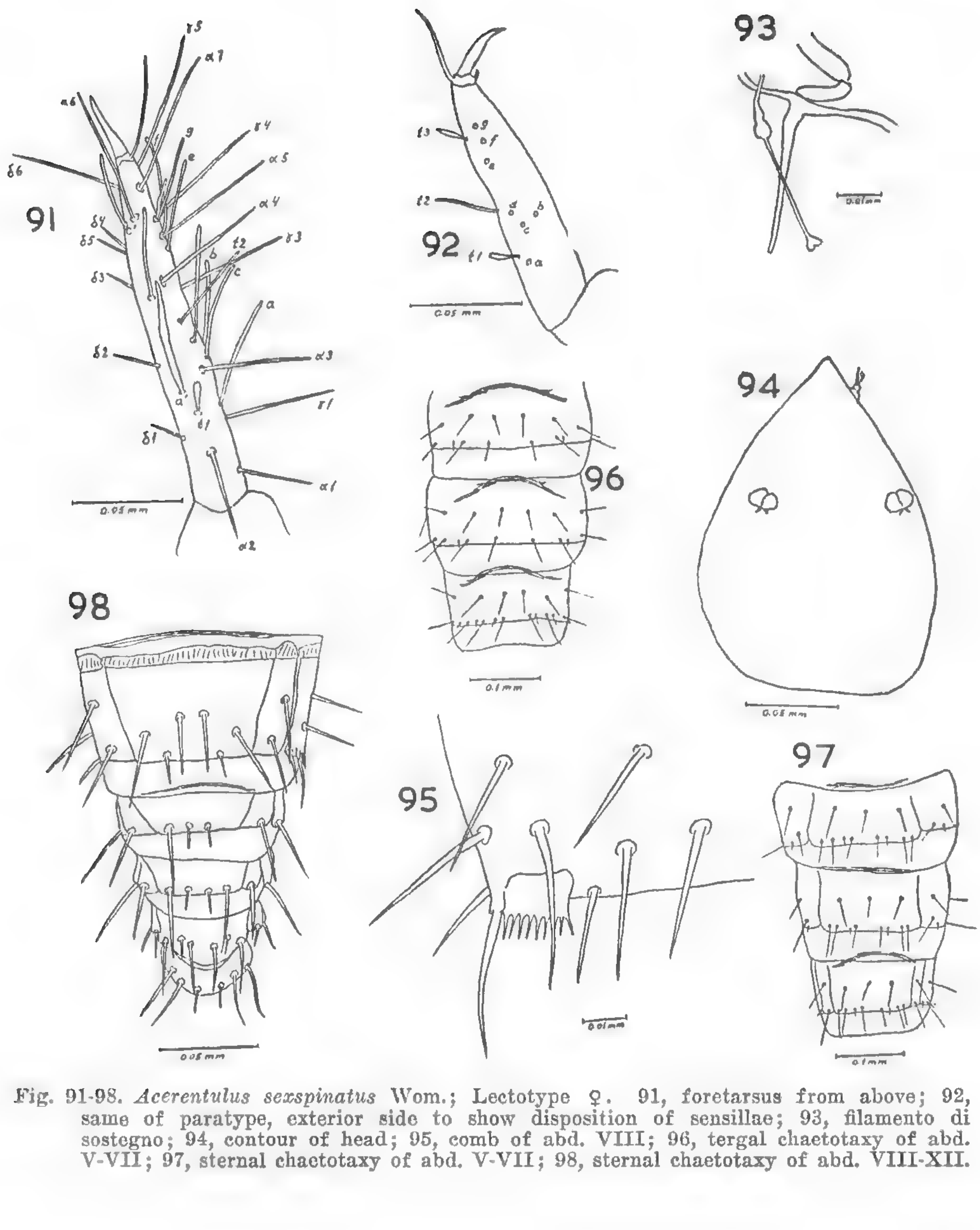

Fig. 91-98. *Acerentulus sexspinatus* Wom.; Lectotype ♀. 91, foretarsus from above; 92, same of paratype, exterior side to show disposition of sensillae; 93, filamento di sostegno; 94, contour of head; 95, comb of abd. VIII; 96, tergal chaetotaxy of abd. V-VII; 97, sternal chaetotaxy of abd. V-VII; 98, sternal chaetotaxy of abd. VIII-XII.

It is important how many accessory setae have been added to the posterior row on tergite VII. Also the number of setae on sternite VIII is different from that in the other Australian species of *Acerentulus.*

Lectotype: A female from "Onkaparinga Riv., Noarlunga, S.A., 25/4/32, D. C. Swan" in the South Australian Museum.

This species is readily distinguished from the other Australian species by the very small claw of the foretarsus, the long t3, the filamento di sostegno and the comb and chaetotaxy of abd. VIII.

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STUDIES OF THE ACARINA FAUNA OF LEAF-LITTER AND MOSS FROM AUSTRALIA

No. 1.–A NEW GENUS AND SPECIES OF PHAULODINYCHIDAE, CORBIDINYCHUS CORBICULARIS, FROM QUEENSLAND (ACARINA, UROPODINA)

BY H. WOMERSLEY, HONORARY ACAROLOGIST, SOUTH AUSTRALIAN MUSEUM

Summary

A new genus and species of Phaulodinychidae, Corbidinychus corbicularis, is described from specimens from leaf-litter from Queensland. Females, males and tritonymphs are known.

The basket-like hyaline fringe of long marginal setae is remarkable and resembles superficially that of a somewhat similar genus and species Clausadinychus cristatus described by Sellnick from Martinique. Comparison of the two species is discussed and they are shown to belong to two different familes of Uropodina.

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Fig. 1-2

SYNOPSIS

A new genus and species of Phaulodinychidae, *Corbidinychus corbicularis,* is described from specimens from leaf-litter from Queensland. Females, males and tritonymphs are known.

The basket-like hyaline fringe of long marginal setae is remarkable and resembles superficially that of a somewhat similar genus and species *Clausadinychus cristatus* described by Sellnick from Martinique. Comparison of the two species is discussed and they are shown to belong to two different families of Uropodina.

Genus **Corbidinychus** nov.

According to the key to the families of the Uropodina given by Baker and Wharton, 1952, based on the studies of Trägårdh and Max Sellnick, this new genus, except for the exposure of the tritosternum between coxae I and the position of the stigma more directly opposite coxae III rather than between coxae II and III, falls into the family Phaulodinychidae Berlese 1917.

The body is dorso-ventrally compressed with the gnathosoma completely hidden under the dorsum. The dorsal shield is entire and occupies most of the dorsum, except for the marginal shields which anteriorly are coalesced with the dorsal and posteriorly are reduced to a pair of short narrower shields, and then a pair of narrow posterior marginal shields. The dorsal shield is punctate and furnished with fine slender tapering setae and a number of pores. The edge of the marginal shield carries a double series of long nude curved setae which extend all round the body except for the posterior one-fifth. The more dorsal of the two series of setae are longer and about one-fifth of the body width; all are furnished with broad irregular hyaline laminae and together they form a hyaline wall braced by the setae, like the sides of a basket. On the posterior fifth of the margin the hyaline membrane is continued but here the setae are in one row and much longer, straight and not so tapering. Ventrally the leg depressions are distinct. Leg I is furnished with a long caruncle and paired claws. The tritosternum has only two laciniae and is clearly exposed between coxae I. The stigma is small, situated directly opposite coxae III and the thin peritreme makes a right angled bend before running to the margin in a double curve midway between coxae II and III. The female genital shield is elongated, with posterior truncate just in front of posterior margin of coxae IV; it reaches anteriorly to middle of coxae II. The metasternal shields are coalesced with the sterno-genital shield. The anus is in the middle of the large ventri-anal shield. In the male the genital orifice is situated between coxae IV, and the anterior cover or operculum is hinged anteriorly and carries a pair of long genital setae.

Corbidinychus corbicularis sp. nov.

Fig. 1, A-F, 2, A-H

Locality: Seven females, four males and three tritonymphs obtained by the Berlese funnel method from leaf-litter from the corner of Haven Road and Upper Brookfield Road, Brookfield, Queensland, 22nd July, 1960 (coll. E. H. Derrick).

Types: Holotype female, allotype male, morphotype tritonymph, and all paratypes in the collection of the South Australian Museum.

Description.

A rather small brownish, dorso-ventrally depressed species with the gnathosoma completely hidden by the dorsum; with a double series of long curved marginal setae forming in life the wall of a basket.

Female holotype. Almost circular in form; length 760μ, width 702μ.

Dorsum: Dorsal shield covering the whole of the dorsum except for the marginal shields, finely punctate with 44 long, 72μ, fine flexible tapering setae of which the middle members of the second and third transverse rows are not paired, almost every seta is accompanied by

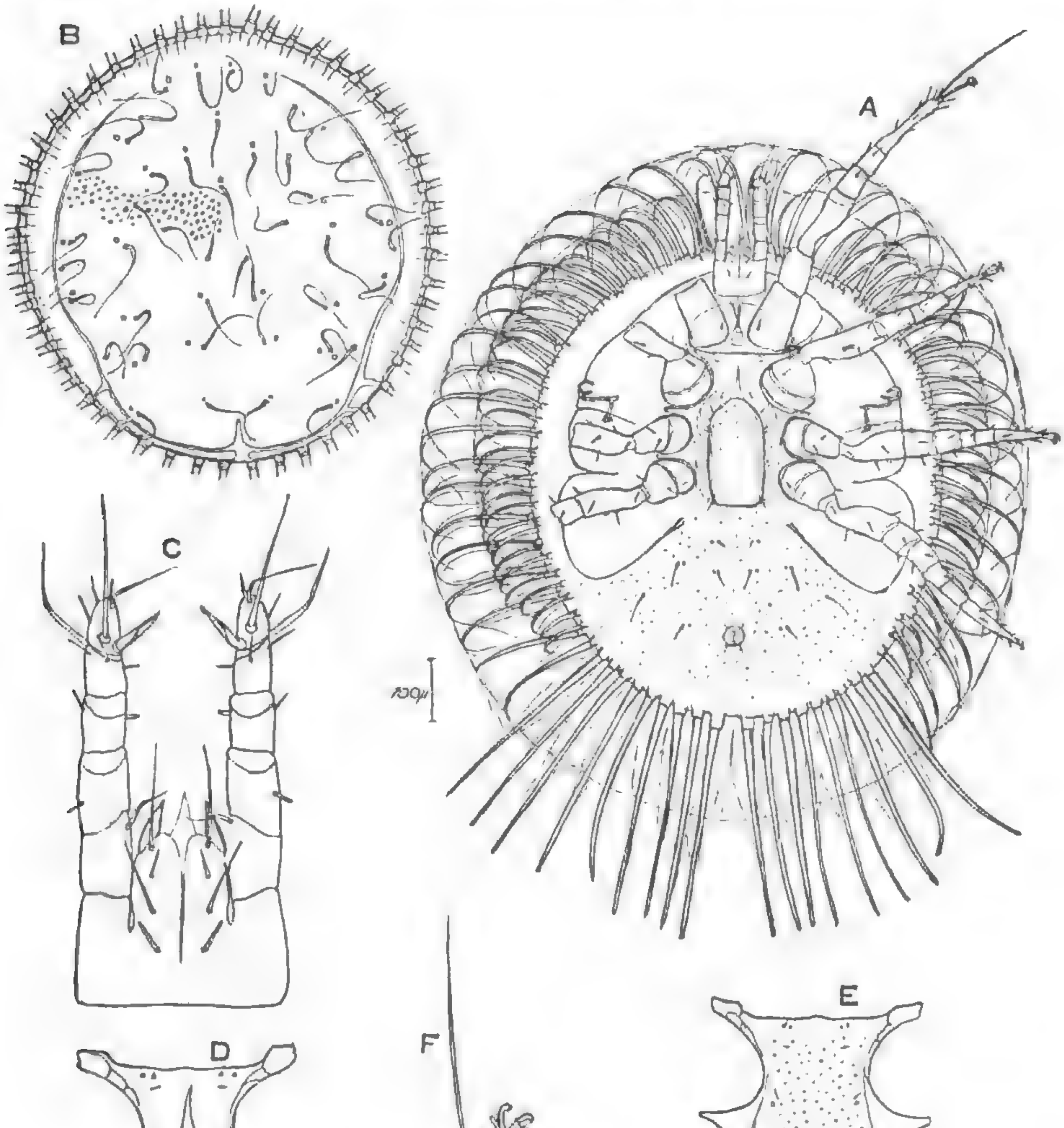

Fig. 1. *Corbidinychus corbicularis* g. et sp.nov. A, ventral view of female; B, dorsum of female; C, gnathosoma, from below; D, sternal and genital shields of female, much enlarged; E, sternal and genital shields of male, much enlarged; F, tarsus of leg I of female.

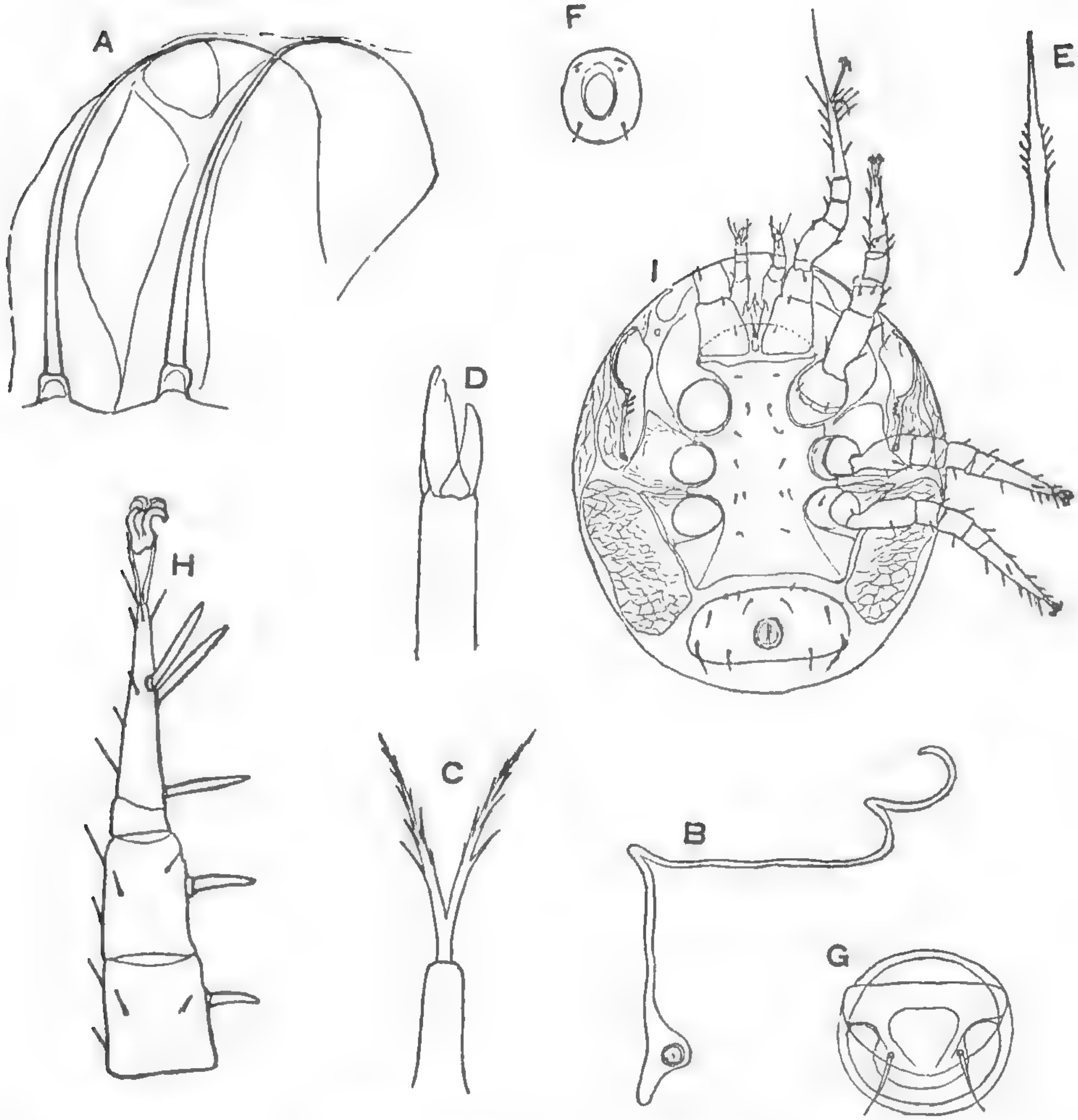

Fig. 2. *Corbidinychus corbicularis* g. et sp.nov. A, two of the long marginal setae showing hyaline laminae; B, peritreme of female; C, tritosternum of female; D, chelicerae of female; E, tectum of female; F, anus of female; G, genital shields of male, much enlarged; H, genu, tibia and tarsus of leg II of male; I, ventral view of tritonymph (marginal setae omitted).

a conspicuous round pore; the shield is 714μ long by 608μ wide, the sides converge inwards slightly from just behind the middle, and posteriorly there is a short incision. The marginal shields are 77μ wide, coalesced anteriorly with the dorsal and reduced posteriorly where they break up into a narrower shield and then into two posterior marginal shields which are only about 20μ in depth and 168μ wide, the marginal shields carry a double series of approximately 27 on each side of long curved tapering setae, the upper series anteriorly extend to 164μ, and medially to 234μ before they curve backwards reaching a total length of ca. 480μ, the shorter setae extend to 117μ: posteriorly about 6 setae on each side in a single series are straighter, less tapering and to 351μ long, all these setae are furnished with wide irregular hyaline laminae and together they form a sort of basket arrangement the sides of which stand up in life to a height of about 234μ.

Venter: Gnathosoma, tritosternum and coxae I set in a distinct camerostome. Tritosternum with elongate basal portion and a single pair of ciliated laciniae. Sternal shield as figured, 210μ wide anteriorly, coalesced with the endopodal and metasternal shields, with 6 pairs of very minute setae, each accompanied by a pore, in addition a lyriform pore just posterior of sternal setae I which are close to the anterior margin, sternal setae II are just anterior of but close to the apex of the perigenital ring, then follows four other pairs of setae, the first of which may be sternal setae III, the last the metasternal setae, and the two intermediate supersternal setae, all these are on the perigenital rim. The genital shield is 168μ long by 96μ wide and slightly overlaps the perigenital ring apically, it is furnished with punctae. The ventri-anal shield is also punctate and carries 6 pairs of largely pre-anal setae of 96μ and 48μ in length.

Gnathosoma: As figured, with four pairs of hypostomal setae which lie in a longitudinal line, the rostral pair are the longest and tapering, the first post-rostral pair of medium length and tapering, the capitular and second post-rostral pairs are shorter and blunt tipped; labial cornicles short and blunt pointed. Chelicerae as figured, fixed digit the longer with two indistinct subapical teeth. Tectum a long slender spike, slightly swollen medially with five pairs of spinelets. Palpi with five free segments, tarsi with two long setae and tined seta stout and two-pronged; genu with a single stout inner spine.

Legs: Generally slender, I 560μ long, II 515μ long, III 515μ, IV 560μ, tarsi I slightly swollen in distal half with long caruncle and paired claws, and with a terminal slender seta longer than the segment, tarsi II-IV with much shorter caruncle and paired claws.

Male allotype. Of the same general facies and dimensions as in the female.

Dorsum: Dorsal and marginal shields as in female, dorsal 690μ long by 526μ wide, marginal 82μ wide; dorsal and marginal setae as in the female.

Venter: Genital orifice between coxae IV, operculum hinged above and furnished with a pair of setae 28μ long, orifice 72μ wide by 62μ long; venter otherwise as in female, and as figured.

Legs: Of the same general structure and length as in the female except that the genu, tibia and tarsus of leg I are furnished with much longer and stouter setae as figured.

Tritonymph morphotype. General facies as in the female. Length 655μ, width 437μ.

Dorsum: Marginal shields not manifest; dorsal shield occupying all the dorsum, with punctae and setae as in the female.

Venter: Sternal shield 172μ wide anteriorly and 192μ wide posteriorly, 322μ long, the posterior margin lightly concave and only separated from the anterior margin of ventri-anal shield by a narrow strip, with apparently only five pairs of minute pores, of which the anterior pair are lyriform. Ventri-anal shield roughly transversely oval, 120μ long by 260μ wide, with five pairs of setae besides the anal setae.

Legs: Depressions for the legs present but on the outside of the depressions with two reticulate shields, one opposite coxae IV an elongate rough oval, and another smaller opposite coxae II and III carrying the peritreme. Otherwise as in the female, all legs about equal, 374μ long.

Remarks. The peculiar and striking development of the marginal setae of this mite is strongly reminiscent of the equally curious form *Clausadinychus cristatus* Sellnick 1930 described from Martinique. Both forms have long setae forming a fringe on the margins of the marginal shields. *Clausadinychus*, however, on the structure of the dorsal shields belongs to the family Prodinychidae whereas *Corbidinychus* belongs to the Phaulodinychidae.

In the new genus and species the body is dorso-ventrally depressed while in *Clausadinychus* it is elevated from front to rear, and the marginal shields form a raised rim which is not so in *Corbidinychus*. The long marginal setae in the Martinique species are finely ciliated, in *Corbidinychus* nude and laminated. The setation of the dorsal shield is different in the two forms. Leg I of *Clausadinychus* lacks any ambulacral apparatus and in the male the genital orifice is longer than wide and situated between coxae II.

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STUDIES OF THE ACARINA FAUNA OF LEAF-LITTER AND MOSS FROM AUSTRALIA

No. 2.–A NEW TRACHYTID MITE, POLYASPINUS TUBERCULATUS, FROM QUEENSLAND (ACARINA, TRACHYTINA)

By H. Womersley, Honorary Acarologist, South Australian Museum

Summary

A third species of the genus Polyaspinus Berlese, 1917, P. tuberculatus sp.nov., is described from specimens collected from leaf-litter from Brookfield, Queensland. Adults of both sexes as well as the larva, protonymph and tritonymph are known.

In his 1953 paper "A Revision of the Cohort Trachytina Trägårdh 1938, etc.", Dr. J. H. Camin has shown on p. 365 that the family Polyaspinidae erected by Trägårdh in 1941 for Polyaspinus cylindricus Berlese 1917 is not justified, and that the genus should be placed in the Trachytidae. It was considered that the characters used by Trägårdh to separate the two families, Trachytidae and Polyaspinidae, were no more significant than those used to separate the four genera included in the other family of Trachytina, the Polyaspidae.

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No. 2.—A NEW TRACHYTID MITE, POLYASPINUS TUBERCULATUS, FROM QUEENSLAND (ACARINA, TRACHYTINA)

By H. WOMERSLEY, Honorary Acarologist, South Australian Museum

Fig. 1-2

SYNOPSIS

A third species of the genus *Polyaspinus* Berlese, 1917, *P. tuberculatus* sp.nov., is described from specimens collected from leaf-litter from Brookfield, Queensland. Adults of both sexes as well as the larva, protonymph and tritonymph are known.

In his 1953 paper "A Revision of the Cohort Trachytina Trägårdh 1938, etc.", Dr. J. H. Camin has shown on p. 365 that the family Polyaspinidae erected by Trägårdh in 1941 for *Polyaspinus cylindricus* Berlese 1917 is not justified, and that the genus should be placed in the Trachytidae. It was considered that the characters used by Trägårdh to separate the two families, Trachytidae and Polyaspinidae, were no more significant than those used to separate the four genera included in the other family of Trachytina, the Polyaspidae.

In his key (*loc. cit.* p. 367) to the families and genera of the Trachytina, Camin separates the Trachytidae and Polyaspidae mainly on the presence or absence of small claws on tarsi I. The first of these families, in which claws are present on tarsi I, contains only the genera *Trachytes* Michael 1894, and *Polyaspinus* Berlese 1917 which he separates as follows:—

> "Body pyriform; metasternal shields narrow, elongate, flanking genital apperture; epigynial shield trapezoidal; dorsal marginal shields entire; dorsum covered by nymphal skins.
>
> Genus *Trachytes*.

Body oval, pointed anteriorly; metasternal shields usually reduced, rounded, at posterior corners of genital apperture; epigynial shield ovoid, truncate posteriorly; dorsal marginal setae on individual platelets; dorsum with fragments of nymphal skins on shields only.

Genus *Polyaspinus*."

Until 1954 only the genotype of *Polyaspinus*, P. *cylindricus* Berl. 1917 was known but in that year Camin described a second species, *P. higginsi*, from a solitary female specimen collected by Mr. Harold Higgins in Idaho, U.S.A.

More recently, however, the present writer obtained a number of specimens of a Polyaspid mite from a collection of leaf-litter from the corner of Haven Road and Upper Brookfield Road, Brookfield, Queensland, made by Dr. E. H. Derrick. These mites have proved to be a third species of *Polyaspinus*, and are here described and figured as a new species, *Polyaspinus tuberculatus* sp.nov. The larval, protonymphal and tritonymphal stages as well as both sexes were present.

Polyaspinus tuberculatus sp. nov.

Fig. 1, A-H; 2, A-H

Locality: In leaf litter from the corner of Haven Road and Upper Brookfield Road, Brookfield, Queensland, 20th July, 1960 (coll. E. H. Derrick).

Types: Holotype female, allotype male and morphotypes of larva, protonymph and tritonymph, as well as six paratype males, and one paratype tritonymph in the collection of the South Australian Museum.

Description.

Female holotype: Fig. 1, A-J, 2, A. A strongly sclerotised, deep brownish species with fragments of nymphal skins adhering. Body boat-shaped with vertex a rounded point terminating in a small bifid tubercle, sides curved and posterior truncate with a pair of large broadly conical processes, flattened dorsally with a slightly concave smooth median strip, slightly convex ventrally, shields strongly areolated. Length of idiosoma 1,088μ, width 678μ.

Dorsum: Fig. 1, B. With a large oval median shield, 749μ long by 433μ wide, strongly sclerotised and areolate laterally but with a clear smooth median strip, on the margins of this strip are 7 pairs of small 24μ setae each of which is accompanied by 2-3 small round

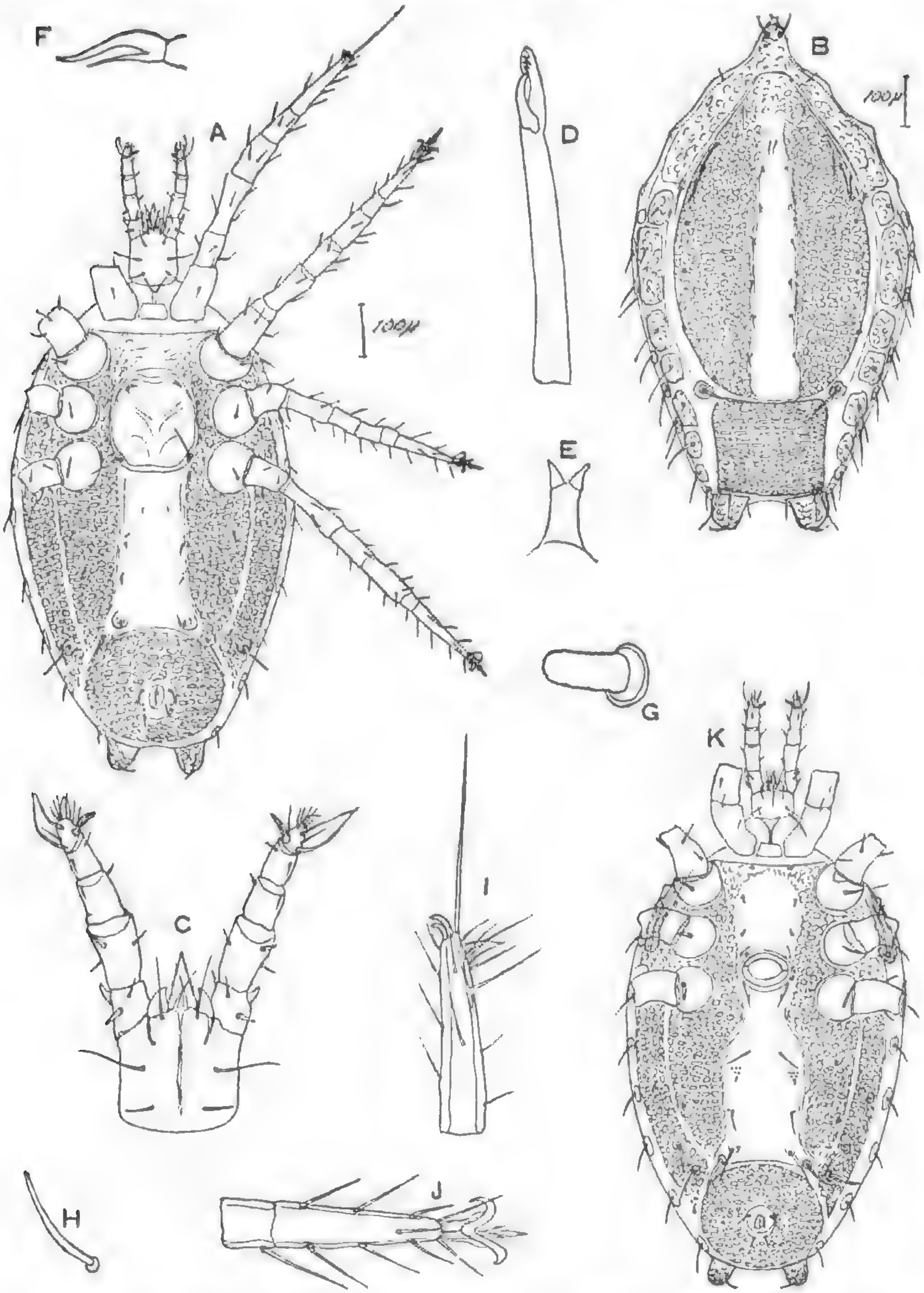

Fig. 1. A-K—*Polyaspinus tuberculatus* sp.nov. A-J—Female. A, venter; B, dorsum; C, gnathosoma ventral; D, mandible; E, tectum; F, tined seta of palpal tarsus; G, short stumpy sternal seta; H, dorsal marginal seta; I, tarsus I; J, tarsus II; K, male, venter.

pores, anteriorly on the lateral margins of the shield are four pairs of strong setae, the anterior pair 24μ long and fine, the others to 48μ long, continuing posteriorly are 4 pairs of pores or ? setal bases; there are two series of marginal setae, the inner is 8 in number on each side, generally situated singly on individual platelets although where two platelets are coalesced two setae may be present, the anterior platelets on each side are elongate and coalesced anteriorly of the dorsal shield they carry the verticle setae of 43μ length and one pair of short setae 24μ long, the setae on the other platelets are 1.2.1.1.1.1. to 96μ long; the outer series of marginal setae are 7 in number to 62μ long and on very small platelets, the anterior one on each side lacks a seta; between the posterior end of the large anterior marginal platelet and the dorsal shield is another small platelet on each side with seta 62μ long, and at the posterior end of the dorsal shield and in front of the antero lateral angles of the posterior shield is another pair of platelets with a stronger seta to 110μ long; the posterior shield is rectangular, strongly areolated, 257μ wide by 187μ long, without setae except for a pair at each posterior corner 72μ long, the outer setae being on raised tubercles: the hysterosoma ends in two large conical characteristic prominences, 67μ long by 72μ wide, each furnished with a short curved 43μ long seta.

Venter: Fig. 1, A. Tritosternum with broad rectangular basal part exposed between coxae I and with paired laciniae; sternal shield coalesced with the endopodals, parapodals and metapodals and surrounding the perigenital rim, posteriorly of coxae IV the combined shield extends to a point midway on each side of the round ventri-anal shield, the shield is strongly areolated except for a wide slightly raised median strip extending from the posterior of the perigenital rim to the anterior margin of the ventri-anal shield and a narrow strip which runs from the posterior margin to coxae IV (fig. 2, A), sternal setae I are close to the anterior margin and accompanied by a lyriform pore, setae II are about midway between I and the apex of the genital rim, III are in line with the angles between coxae III and IV, two supersternal setae lie close to the perigenital rim opposite coxae III, all these setae are short and stumpy (fig. 1, G) and II III are accompanied by small round pores; the median strip expands posteriorly and carries 5 pairs of setae, the anterior pair being short and stumpy and submedian in position, the second and third pairs are longer and spine-like and lateral on the margins of the strip, the fourth pair are short and stumpy and placed on strong tubercles, the fifth pair are at the extreme end of the postero-lateral expansions of the median strip and

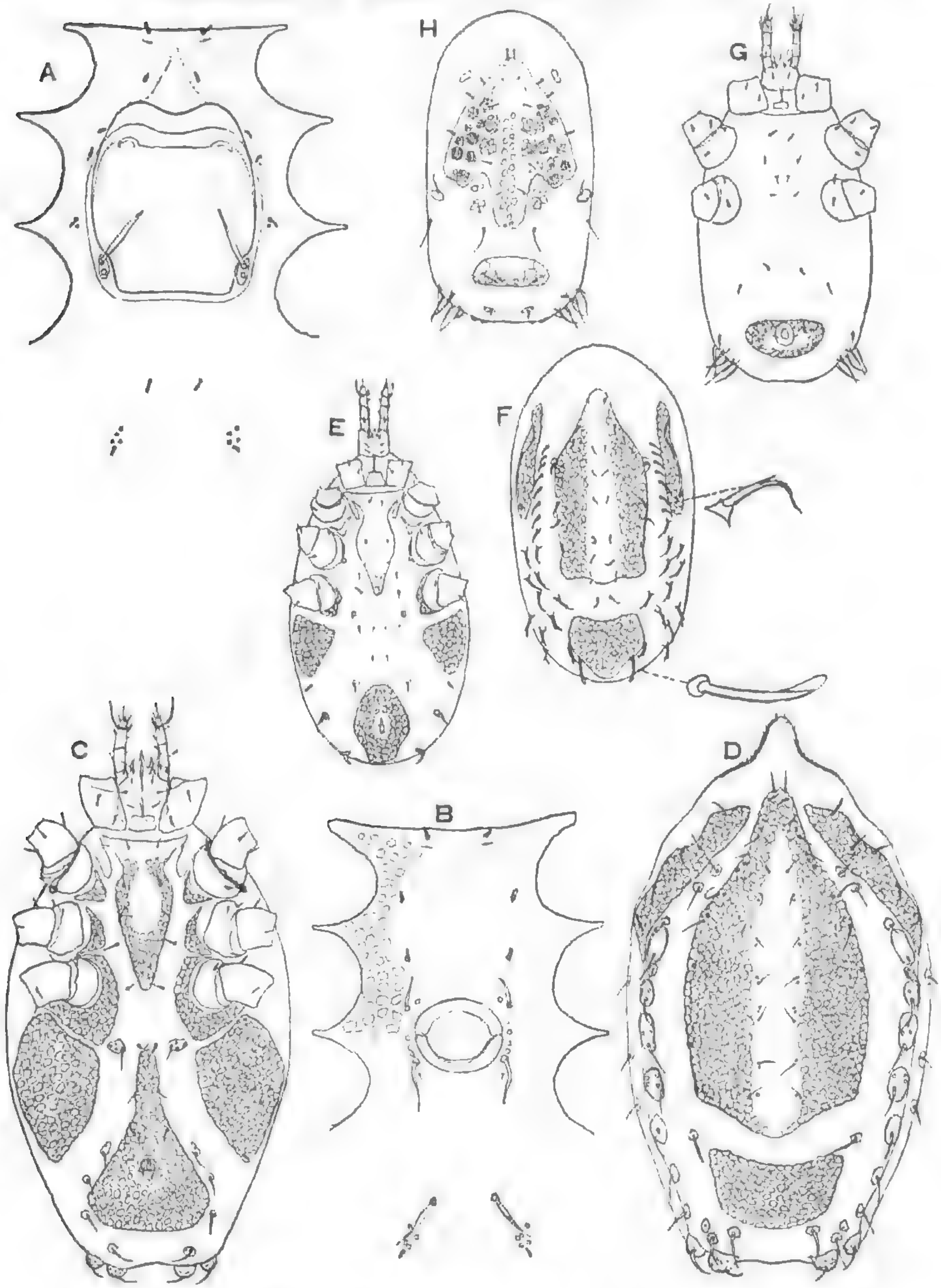

Fig. 2. A-H—*Polyaspinus tuberculatus* sp.nov. A, genital area of female, enlarged; B, same of male; C, tritonymph ventral; D, same dorsal; E, protonymph ventral; F, same dorsal; G, larva ventral; H, same dorsal.

also on strong tubercles and with a strong 96μ spine-like seta, the inner areolated portions of the shield carry two 40μ setae on each side and the outer areolated portions a stronger posterior tubercle with seta 96μ long; the ventri-anal shield is round, strongly areolate, 288μ long by 307μ wide, with the anus posterior of the mid-line and with only the two pairs of anal setae; the metasternal shields are reduced, rounded, and situated in the postero lateral corners of the perigenital rim, they carry a strong seta 72μ long and a small round pore.

The genital shield is oval with an excavate anterior and a truncate hinged posterior margin, it overlaps the similarly shaped perigenital rim anteriorly, and is without setae, it is 192μ long by 182μ wide. The stigmata are situated opposite coxae III with short peritreme reaching to coxae II.

Gnathosoma: As figured; fig. 1, C. With four pairs of hypostomal setae in a longitudinal row, the posterior post-rostral and the rostral setae about twice as long as the capitular and anterior post-rostral setae; the labial cornicles are short and broad.

The chelicerae, fig. 1, D as figured, the moveable digit is edentate and shorter than the fixed digit, the apex of which is dentate. The palpi, fig. 1, C are 5-segmented, the first free segment with two short stout spines and the femora with an outer anterior spine, tarsus with 2-tined basal seta and long subterminal setae. The tectum is of peculiar form (fig. 1, E) with cylindrical basal part topped by two outwardly directed conical pieces.

Legs: Generally fairly slender and shorter (fig. 1, I), than the body, I 702μ long, tarsi I with a pair of small sessile claws and a long 192μ terminal seta, II 760μ long, III 643μ, IV 819μ; tarsi II-IV (fig. 1, J), with ambulacra of short caruncle, pointed pulvillus and strong paired claws.

Male allotype. General facies as in the female. Length of idiosoma 1,110μ, width 642μ.

Dorsum: Shields and chaetotaxy as in the female.

Venter: Fig. 1, K. Shields coalesced and areolated as in the female. Genital shield (fig. 2, B) transversely oval, 96μ wide by 82μ long, situated between coxae III and IV; sternal setae I and II and supersternal setae short and stumpy situated as in fig. 2, B; III in line with the anterior margin of genital orifice and long with accompanying pore, only one pair of supersternal stumpy setae present; metasternal setae long and tapering, in line with posterior of genital orifice, setae posterior of genital orifice as in the female but the first two pairs longer and pointed; otherwise as in the female in all respects.

Gnathosoma: Palpi, chelicerae, and tectum as in the female.

Legs: Somewhat shorter than in the female, I 667μ long, II 702μ long, III 643μ, IV 760μ.

Larva morphotype: Fig. 2, G-H. Of oval shape. Length of idiosoma 585μ, width 328μ.

Dorsum: Fig. 2, H with a large spear-head shaped median shield 331μ by 250μ wide, not reaching nearly to the anterior of dorsum, ornamented with areolations as shown, furnished with 9 pairs of small setae including the verticles, of these the three marginal pairs are stumpy, the others pointed; on each side slightly posterior of the vertex is a small irregular platelet without setae, posterior of the lateral corners is another small platelet with a seta, in the posterior angles of the spear-head are a few areolae, in a transverse row in line with the posterior tip of the shield are four simple setae to 57μ long; posterior shield transversely oval with flattened anterior and posterior margins, 144μ wide by 48μ long and areolate only on the posterior half, without setae; posterior of this shield is a pair of submarginal platelets bearing a short seta while laterad of these on each side is a cluster of 5 slender tapering setae to 57μ long.

Venter: As figured (fig. 2, G), with only a posterior ventri-anal shield, podal and sternal shields absent, the sternal and metasternal shields only represented by four pairs of minute setae; ventri-anal shield reticulate, 144μ wide by 72μ long, with a straight anterior margin, and with only the anal setae, anterior of this shield is a procurved line of four short setae.

Legs: I 292μ long, II 347μ, III 347μ, all rapidly tapering.

Protonymph morphotype: Fig. 2, E-F. Of oval shape, length of idiosoma 585μ, width 328μ.

Dorsum: Fig. 2, F. With a large median shield, smaller posterior and a pair of elongate marginal shields, the median shield is 307μ long by 173μ wide, longitudinally rectangular except for the anterior third which tapers to a rounded vertex, it is areolate on the lateral thirds and smooth and slightly depressed medially, on the median strip it carries 7 pairs of short stumpy setae including the verticles, and on the lateral margins five pairs of setae; the anterior lateral marginal shields are 216μ long by 48μ wide, without setae, areolated and they carry the stigmata and peritreme; the posterior shield is pentagonal, 120μ long by 144μ wide, areolate with a lateral marginal pair of spathulate setae to 48μ long; on the cuticle, between the median and lateral shields and posterior thereof are 19 pairs of strong setae which probably represent the marginal setae of the adults, of these 6-7 pairs lie between the marginal shields and the median, the remainder to ca 38μ long arise from small tubercles and generally are curved, tapering, with a short lateral branch.

Venter: Fig. 2, E. Sternal shield elongate, widest anteriorly to 120μ, then contracting to 29μ between coxae II, expanding to 62μ between coxae III and then tapering to a point at about midway of coxae IV, length 192μ, the anterior corners are united with the endopodal shields of coxae II to form short lobes, the shield is furnished with one pair of small setae and two pairs of pores ? or minute setae, the posterior tip is areolate; ventri-anal longer than wide, 144μ by 106μ, elongate ovoid but slightly constricted in posterior half, areolate except for the anal region, with one pair of minute setae and the anal setae; metapodal shields free, large, triangular and reticulate, 72μ wide by 120μ long; on the cuticle between coxae IV and between the metapodal shields with 5 pairs of minute setae of which the third and fourth pairs are in a transverse row, laterad of the ventri-anal shield on each side are four stronger curved setae on tubercles.

Legs: I 292μ long, II 316μ, III 292μ, IV 351μ.

Tritonymph morphotype: Fig. 2, C-D. Ovoid in shape, with conical vertex, sides convex, posterior margin truncate with a pair of short conical processes on each side of the inner ones as in the adults. Length of idiosoma 950μ, width 526μ.

Dorsum: Fig. 2, D. With a large median shield as figured, with conical vertex, convex sides and sinuate convex posterior margin, setation and areolation as in the adults; marginal setae in two series of about 12 on each side on the individual platelets of varying size and accompanied by 1-3 pores, setae to 57μ long, outer series of 8 setae on each side to 48μ long of which the first 5 are situated on the elongate anterior marginal shields; posterior shield wider than long, 240μ by 120μ, with concave anterior margin and convex posterior margin, areolate, without setae; a pair of setae 57μ long, on small platelets in front of the anterior corners of the posterior shield.

Venter: Fig. 2, C. Sternal shield of the same shape as in the protonymph, with more extensive areolation, 192μ wide anteriorly contracting to 82μ between coxae II and then expanding to 106μ before tapering to a point midway of coxae IV, with 3 pairs of simple setae; endopodal shields well developed and areolate; metapodal shields large, triangular, 312μ long by 178μ wide, areolate; ventri-anal shield shaped like a conical flask with neck about one third of its height, areolate, with two pairs of setae anterior of the anal region, which is slightly posterior of the mid-length of the shield; between the sternal shield and coxae III and IV are two pairs of setae; just anterior of the tip of the ventri-anal shield is a transverse row of 4 setae of which the outer members are on small platelets; laterad of the posterior half of the ventri-anal shield are three pairs of strong setae, each on small platelets and posterior of the shield is another similar pair.

Legs: I 560μ long, II 562μ, III 585μ, IV 595μ.

Remarks. While it is doubtful whether the form described here as the tritonymph is really that stage or the deutonymph, the development of the marginal shields suggests the tritonymph. No other stage has been seen.

From the other known species of the genus, *tuberculatus* can be readily distinguished by the posterior tubercular processes in both the adult stages. It is also a somewhat larger species than either *cylindricus* or *higginsi*.

To Dr. E. H. Derrick of the Queensland Institute for Medical Research the writer expresses his sincere thanks for the collection of many leaf-litter samples from which much interesting material such as the above is being obtained.

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Summary

The Trachytid mite Calotrachytes sclerophyllus (Michael) from New Zealand hitherto only known from the unique female in the British Museum (Nat. Hist.) is redescribed and figured from two further females in the collection of the South Australian Museum. The unknown male and nymph are also described from single specimens in the same collection.

The genus Calotrachytes was erected in 1917 by Berlese as a sub-genus of Polyaspis for the unique female specimen described by Michael 1908 from New Zealand as Trachynotus sclerophyllus. Apart from the solitary female in the British Museum (Nat. Hist.) no further records of the species appear to have been published nor has it been refigured. However, in 1953 Dr. J. H. Camin in his paper "A Revision of the Cohort Trachytinae Trägårdh, 1938, etc.", gave a detailed generic diagnosis of Calotrachytes based on a study of the type made for him by Dr. G. O. Evans of the British Museum.

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Fig. 1

SYNOPSIS

The Trachytid mite *Calotrachytes sclerophyllus* (Michael) from New Zealand hitherto only known from the unique female in the British Museum (Nat. Hist.) is redescribed and figured from two further females in the collection of the South Australian Museum. The unknown male and nymph are also described from single specimens in the same collection.

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Camin's diagnosis is as follows: "Metasternal setae on small metasternal shields behind posterolateral margins of epigynial shield, within perigenital rim. Epigynial shield rectangular with rounded corners, slightly longer than broad, extending from behind anterior margin of coxae IV almost to middle of coxae II; apparently articulated within perigential rim, anterior to metasternals. Genital apperture completely surrounded by narrow perigenital rim, which bears sternal setae II and III and the pseudosternals. Sternal setae I on sclerotized anterior margin of sternal shield. Metapodal and anal shields fused, forming a single shield covering ventral opisthosoma, with transverse row of four very large ventral setae anterior to anus. Tritosternal lacina with several short branches, without long setules. Peritremes extending from stigmata opposite coxae III to middle of coxae II, then directed outward to margins of body. Dorsal median shield covering most of the dorsum, posterior dorsal shield small, little more than one-tenth the length of the median dorsal shield, without setae. Marginal setae very large, leaf-like, free or on independent platelets. Corniculi moderately long, blade-like reaching slightly beyond distal margins of palpal femora. Chelicerae as in *Dipolyaspis*; fixed digit slightly longer than moveable digit and with hooked tip. Palpal tibiae and tarsi insensibly fused. Male and immature stages unknown.

Type *Trachynotus sclerophyllus* Michael, 1908".

Recently in the collection of the South Australian Museum the writer has located four specimens labelled tentatively as "Polyaspidae, gen et sp.nov." sent to him some years ago by Mr. E. D. Pritchard of Manurewa, New Zealand. These were collected from moss or leaf debris by means of the Berlese funnel.

Although the preparations are not now in the best of condition, mainly through loss of some of the setae, the specimens can definitely be identified as Michael's species. The female agrees fully with Camin's generic diagnosis and with the figures, especially the excellent dorsal view, given by Michael. Hitherto the male and immature stages were unknown but besides two females one preparation is that of a male and one a ?deutonymph. The male also agrees well with Camin's diagnosis except for the genital shields and also agrees dorsally with Michael's figure of the female dorsum. The specimen is described herewith, as is also the nymph. The generic diagnosis of Camin is modified to include the male.

Genus **Calotrachytes** Berlese

Berlese, A., 1917: Centuria prima di acari nuovi, Redia 12: 28 (as a subgenus of *Polyaspis*).

Type *Trachynotus sclerophyllus*, Michael 1908.

Camin, J. H., 1953: A Revision of the Cohort Trachytina Trägårdh 1938, with the Description of *Dyscritaspis whartoni*, a new Genus and Species of Polyaspid mite from Tree Holes. Bull. Chicago Acad. Sci., 9 (17): 335-385.

Calotrachytes sclerophyllus (Michael)

Trachynotus sclerophyllus Michael 1908: Unrecorded Acari from New Zealand. J. Linn. Soc. London—Zool. 30: 145-147, pl. 17, fig. 4, pl. 21, fig. 25.

Calotrachytes sclerophyllus Berlese 197, Redia 12: 28.

Calotrachytes sclerophyllus Camin 1953. Bull. Chicago Acad. Sci. 9 (17): 335-385.

Text fig. A-H.

Locality: Two females and allotype male from moss, Waimamaka, New Zealand, 21st October, 1938 (coll. E. D. Pritchard); paratype male and morphotype nymph from Ohau Lavin, New Zealand, 25th November, 1936 (coll. E. D. P.).

Types: All specimens in the South Australian Museum.

Description.

Female. The two specimens studied are somewhat longer than the type; the lengths are 1,193μ and 1,112μ and the widths 936μ and 877μ (Michael gives 930μ and 580μ[(1)]). Otherwise they fit well the generic diagnosis of Camin and the detailed description of Michael. The dorsal shield measures 877μ long by 596μ wide (second specimen 760μ by 585μ and the posterior dorsal shield 257μ wide by 117μ long (257μ by 98μ)). The marginal dorsal setae are damaged but much as in Michael's fig. 4, pl. 17. The sternal shield is 351μ wide anteriorly (304μ), 560μ long (468μ), and 398μ wide posteriorly (374μ) in a line between posterior margins of coxae IV; it is furnished with 4 pairs of strong setae of which sternal setae I are ?μ long, straight, blunt (33μ) and 105μ apart situated near anterior margin; sternal setae II and III and a pair of supersternal setae are situated on the perigenital rim, II about level with the tip of the orifice, III just posterior thereof and the supersternal about three times as far back, these setae are long and curved, II and III 38μ long and supersternal 62μ. The metasternal shields are close to the posterior of the perigenital rim and their seta is strong and curved to 72μ long. The genital orifice is 292μ long by 210μ wide (246μ by 187μ). The large ventri-anal shield is 936μ wide by 491μ long (880μ by 468μ); the two pairs of setae are about level with the middle of the anus and not slightly anterior thereof as stated by Michael and Camin, they are about 144μ long by 48μ wide. The gnathosoma is as figured with four pairs

(1) All the measurements given here are on the mounted specimens.

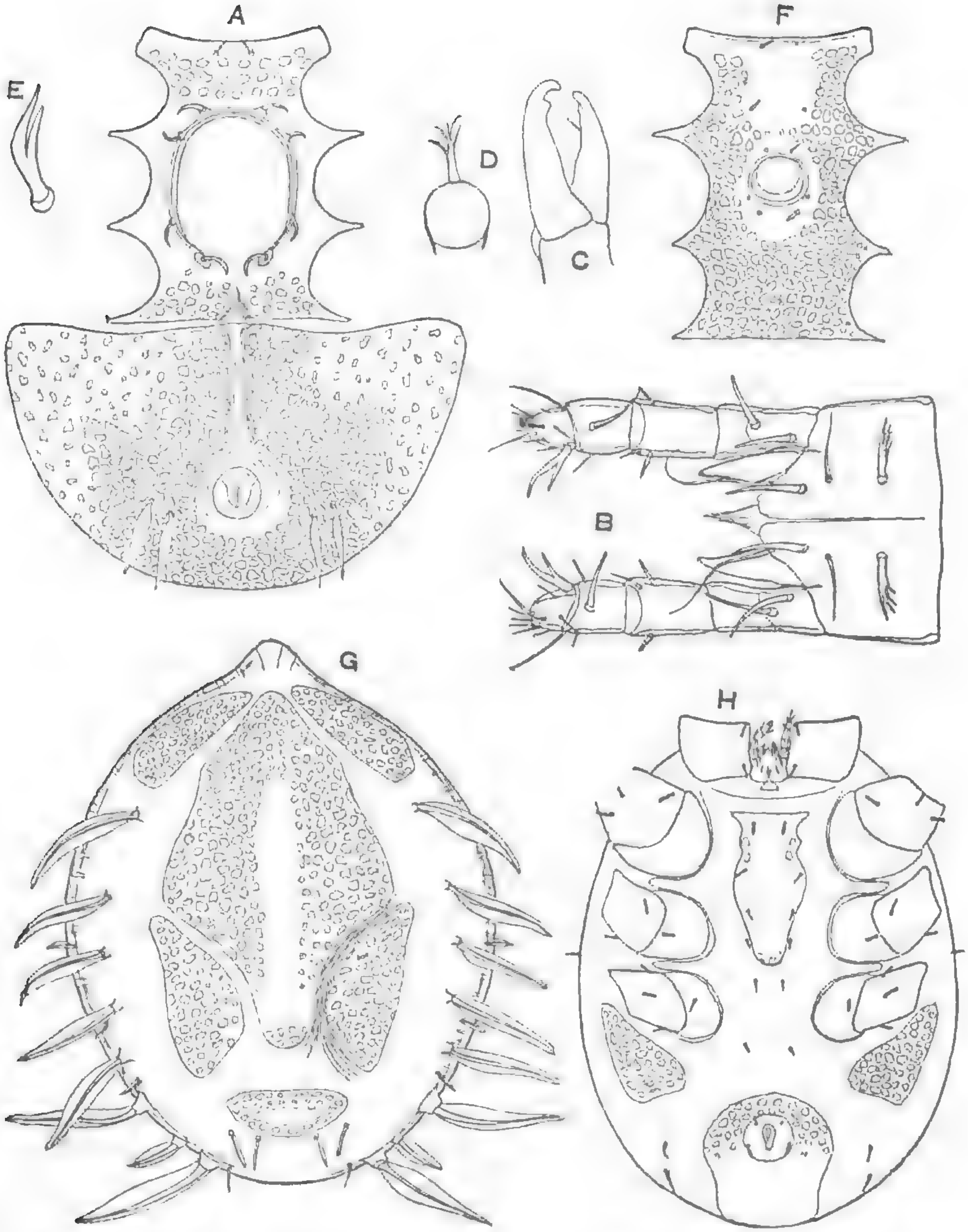

Fig. 1. *Calotrachytes sclerophyllus* (Michael). A-E—Female. A, sternal, genital and ventri-anal shields; B, gnathosoma ventral; C, chelicerae; D, tritosternum; E, tined seta of palpal tarsus; F, male, sternal and genital shields; G-H, nymph; G, dorsum; H, venter.

of hypostomal setae of which the capitular pair are short and thick and branched, the posterior post-rostral pair fine and slender, the anterior post-rostral pair stout, and the rostral pair long and slender almost reaching the tip of palpal genu; the palpal femur is furnished with two stout setae, the tibia and tarsus are not insensibly fused as stated by Camin but quite differentiated. The chelicerae, tectum and tritosternum are as described and here figured. The legs are as has been described, and the lengths, from the second and smaller specimen only are I 772μ long, II 842μ, III 702μ, IV 936μ.

Male allotype. Of the same general facies as in the female; length 1,170μ, width 901μ.

Dorsum: As in the female. Anterior dorsal shield 959μ long by 630μ wide, posterior dorsal shield 292μ wide by 117μ long. Marginal dorsal setae as in female.

Venter: Sternal shield 351μ wide anteriorly, 550μ long and 362μ wide posteriorly, with 5 pairs of setae including the supersternals and metasternals but these setae are smaller than in the female. The genital orifice is wider than long 91μ by 77μ and is situated between coxae III. The ventri-anal shield is as in the female, 795μ wide by 445μ long. The tritosternum, gnathosoma, etc., as in the female. The legs are also much as in the female but II and III are relatively longer, the lengths being I 1,100μ, II 1,048μ, III 994μ, IV 936μ.

Nymph, ? Deutonymph. General facies as in the female; length 912μ, width 749μ.

Dorsum: Median dorsal shield somewhat arrow-head shaped, 468μ long, sides diverging to a width of 421μ at about on a level with coxae III and then curving inwards to a rounded apex, with large irregular pitting as figured, antero-lateral of the dorsal shield with an elongate pair of shields and postero-laterally with another pair 269μ long by 117μ wide, posterior of the median shield with a small shield 220μ wide by 101μ long, posterior of this shield with four short blunt setae, marginal dorsal setae as figured.

Venter: With a small elongate tongue-shaped sternal shield, reaching to posterior of coxae III and constricted between coxae II, 144μ wide anteriorly and 237μ long with three pairs of minute setae on shield. Metapodal shields triangular 201μ long by 86μ wide. Anal shield as figured, as long as 240μ wide.

Legs: Much as in female, I ?, II 919μ long, III 702μ, IV ?

A NEW SPECIES OF CHLENIAS (LEPIDOPTERA, BOARMIIDAE) ON ACACIA ANEURA, WITH SOME CENTRAL AUSTRALIAN NATIVE BELIEFS ABOUT IT

By Norman B. Tindale, Acting Director, South Australian Museum

Summary

Chlenias inkata, a new Boarmiid moth with an apterous female, apparently adapted for existence in an arid environment, is described and figured from Haast Bluff, Central Australia. Its life history on common mulga (Acacia aneura) is outlined, and some aboriginal Australian beliefs abut its larvae are given..

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Fig. 1-9

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INTRODUCTION

During field work with the University of Adelaide Anthropological Expedition to Haast Bluff Station, in the Western MacDonnell Ranges, Central Australia, August, 1957, many Boarmiid larvae were noticed feeding on the needle-like phyllodes of mulga, *Acacia aneura*.

When disturbed either by such sounds as the clapping of hands, by shouting, or by throwing a stick into the trees, many hundreds of the larvae would drop down suddenly from the branches on long silken threads so that the tree instantly seemed to develop a silken aura. The effect was spectacular when many larvae were present. These larvae would remain suspended perhaps three to six feet from their previous perches. After an interval as long as 10 or 15 minutes they would haul themselves up again to their feeding positions.

Observations were made, specimens of the larvae placed in KAAD solution, and, prior to returning to Adelaide, some 25 live larvae were collected on 5th September, 1957. By this date they were far fewer in numbers. Those taken alive all appeared to be in the last larval instar and were from 20 to 25 mm. in length, with head diameters approaching or slightly exceeding 3 mm. In Adelaide these larvae were fed on phyllodes of mulga which had been kept fresh in a humid atmosphere until required.

Most of the larvae continued to feed until early October. All but two of them then rested in what appeared to be a pre-pupal phase for about three days, and had pupated by 5th October. The remaining two were still feeding on that day and later proved to be ones which were parasitised. They were active for several more days. From them appeared Tachinid fly larvae which pupated outside their hosts' bodies.

Pupation of the *Chlenias* larvae took place in shallow loose sand in the breeding box without indication either of a cocoon or of the spinning of silk.

The pupae had a tough cuticle, were pale creamy white, and darkened quickly to a deep chestnut brown. They were kept at normal indoor temperatures at Blackwood, near Adelaide, through the following months.

At the end of a year (August 1958) a Tachinid fly emerged; the other fly pupa died. At some time between August 1958 and January 1960, when I returned from a long visit to the United States, a Braconid wasp parasite was found to have emerged from one of the pupae. Of the remainder, at that date, some still lay dormant, others were apparently dead. They were tested by placing them against the tip of the tongue; seven of those which seemed distinctly cold to the touch of this member were alive.

In August 1960, after two years and ten months, two male moths emerged as adults and were discovered alive, but moribund, in the breeding box on 14th August. One was fully winged, the other was crippled and three of its wings were not fully expanded. Some time afterwards a wingless female emerged and freed itself from its pupal integument before succumbing. It was not noticed until after it had died. A second female was then found dead in a fully developed condition within its broken pupal shell, and further dead male examples were dissected from their pupal skins.

When this paper was being prepared for press in January 1961 two of the original pupae were still alive after three years and three months.

Brief reference was made to the larvae of this moth, as attacking *Acacia aneura*, in a paper on the vegetation of Haast Bluff, by Cleland and Tindale (1959, p. 134). In that paper they were tentatively identified as Geometrids, related to *Amelora*. Rearing of the adult moths now makes possible a more detailed account of the species and warrants giving details of its life history.

Chlenias inkata sp. nov.

♂ Antennae strongly bipectinate, pectinations long, slender, delicately haired, those near middle of length of antenna are about eight times as long as the diameter of shaft; long pectinations continue nearly to the apex. Head, patagia, and tegulae clothed in pale fawn hairs; head with face truncate, dark brown, tips of palpi just visible from above; abdomen pale brownish-fawn with long spine-like hairs of two sizes overlying more normal scales, the spine-like hairs become less obvious towards tip of abdomen. Forewings broad, well rounded, apex rounded, lightly scaled, pale brownish-fawn with isolated flecks and scattered groups of darker brown scales; these are concentrated into slightly more obvious groups on a subterminal part of each of the veins from near the anal angle to Cu_{1a} at about $\frac{3}{5}$th—these darker scales continue in diminishing numbers on each vein to apex, with traces of other lesser groups extending towards costa at $\frac{3}{5}$ths; fringes concolorous, anal margin clothed with longer pale silky hairs. Hindwings paler, sub-hyaline, delicately scaled, with fine hairs along the veins; fringes also delicately scaled, concolorous. Wing length 14 mm. Expanse 30 mm.

♀ Antennae filamentous, not pectinate, not markedly tapering except near apex. Head with front rounded, smooth, dark brown, palpi not visible from above. Wings absent or with only small traces of wing buds. Patagia and tegulae with long dark brown hairs, legs normal, smooth, clothed with firmly adpressed greyish fawn scales. Abdomen stout, with smooth integument, clothed in long, straight, spine-like brown hairs each posteriorly directed; normal scales virtually absent; each abdominal segment somewhat laterally produced (in the dried out condition); these apparent processes become larger on the 6th and 7th segments; the last named process is semicircular and seemingly strongly chitinised. These may be post-mortem effects. Total length 11 mm.; greatest width of abdomen 4 mm.

Loc.: Central Australia; Haast Bluff Station, at 2,000ft., collected by N. B. Tindale, as larvae, in September 1957 and reared out in 1960.

Material: Type male (pupated October 1957, emerged August 1960) and allotype female (pupated October 1957, taken dead from remains of pupal skin): a paratype male with crippled wings (pupated October 1957, emerged August 1960) and other specimens dissected from dead pupae, including a paratype female which died just after emergence. Some larvae and pupae are preserved in alcohol and there are six slides of parts of bodies and genitalia preparations. All are registered as No. I.19110 in the South Australian Museum.

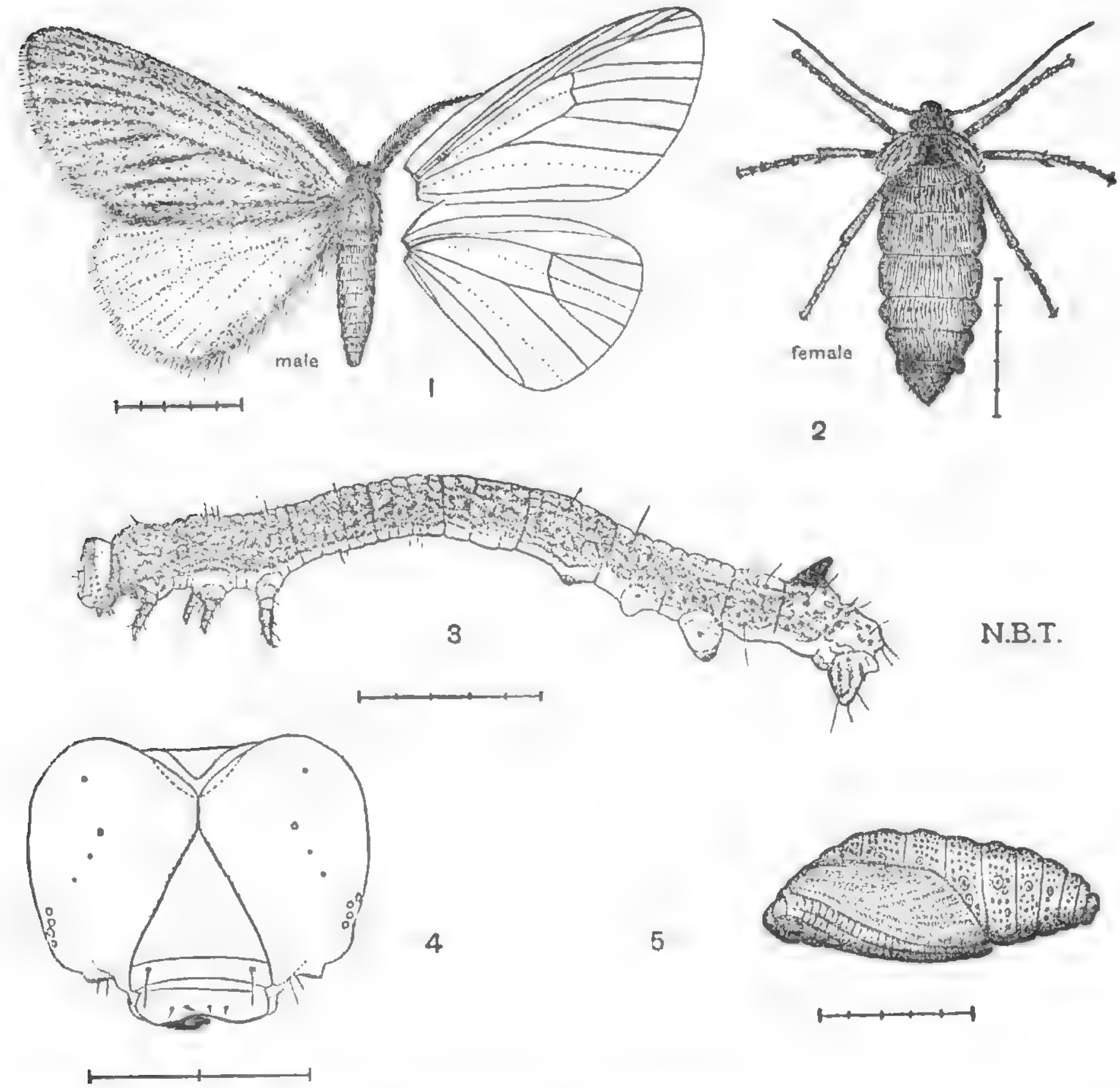

Fig. 1-5. *Chlenias inkata* Tindale. Fig. 1, male, Haast Bluff, Central Australia, 2,000ft.; Fig. 2, female, same details; Fig. 3, larva of last instar, September, 1957; Fig. 4, anterior view of head; Fig. 5, pupa of a male (where a scale is shown alongside a drawing it is to be read in millimetres).

The drawing of the male (fig. 1) is based principally on the holotype, but as the antennae of this specimen were damaged before the drawing was inked in, details were completed with the aid of other males, principally an example marked B, which has been prepared as a slide mount. The illustration of the female (fig. 2) is based on the allotype.

The adult male moth is a dismal looking and obscure member of its genus. In general appearance it seems to be nearest to *Chlenias cyclosticha* Lower (1915, p. 477), which was described from a single male taken at Broken Hill, New South Wales, in June, at a light; the type and only known specimen is in the South Australian Museum where its registration numbers are L.4389 and I.18216.

C. inkata differs from *C. cyclosticha* in its smaller size, shorter, less markedly pectinate antennae, shorter palpi and in its general appearance. The male genitalia differ in some essential points which are detailed below; sufficient basic resemblances remain to suggest that they fall into the same section of the genus *Chlenias.*

The two male genitalia drawings of *Chlenias inkata* (fig. 6-7) are based on a paratype specimen marked B, dissected from its pupal shell. The drawing was checked against a second example (specimen A), which also had been dissected from its pupal integument.

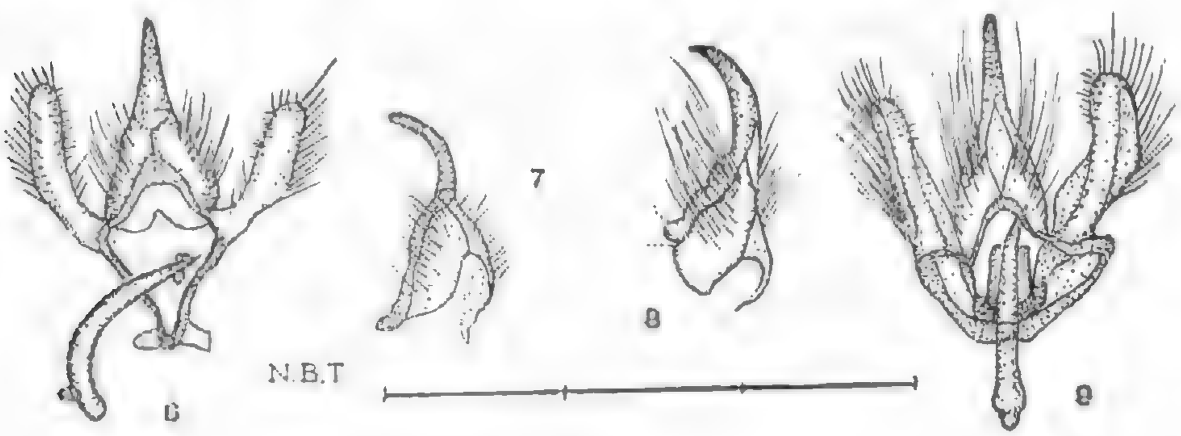

Fig. 6-9. Fig. 6, *Chlenias inkata* Tindale, dorsal view of male genitalia; Fig. 7, *ditto*, oblique view to show form of uncus; Fig. 8, *Chlenias cyclosticha* Lower, oblique view of uncus of male genitalia; Fig. 9, *ditto*, dorsal view of male genitalia (the scale to be read in millimetres).

Viewed from the dorsal surface the male genitalia of *C. inkata* differ from those of *C. cyclosticha* in the broader uncus, tapering to an acute point instead of a more rounded one. The harpes of *C. inkata* are simple, less expanded and with less evidence of flanges. The penis appears more slender. In oblique view the uncus also appears more slender in *C. inkata* than in *C. cyclosticha* and rounded at the tip instead of sharp-pointed, thus reversing the appearance as viewed from above. In the two oblique views given, uncus and its connections are drawn principally to show the form of the apex.

The hairs in *C. cyclotricha* appear stouter than in *C. inkata* but this character must be used with caution since the mode of preparation disturbs the orderliness of such hairs.

The genitalia slide preparations were cleared in caustic potash, imbedded in P. V. A. in standard hollow cells, and ringed with a polyvinyl glue preparation.

In general the genitalia of *C. inkata* seem more compressed or widened when viewed from above while the corresponding parts of *C. cyclosticha* are more slender when viewed from this direction.

Possibly *C. cyclosticha* and C. *inkata* represent ancestral races which through long isolation from each other have become sufficiently different to be regarded as species. If this opinion is not correct and the differences have been unduly magnified they may at the least be regarded either as valid races or ends of a cline of a desert species living on both the northern and the southern sides of the belt of maximum aridity in the Australian sub-tropics. From the appearance of genitalia it can be deduced that these two species are relatively more closely related to each other than either are to the members of the section of the genus which contains *Chlenias pini* Tindale (1928, p. 43).

In searching for the life history of *C. cyclosticha* larvae should be sought on several species of *Acacia* related to *A. aneura* which occur at Broken Hill. Many Haast Bluff larvae were in the penultimate and early last instar phases of their life when first taken in August. It is possible, therefore, that, as in so many other species of *Chlenias,* the adults of *C. inkata* laid their eggs during an early month of winter, either June or early July. Lower's specimen of *C. cyclosticha* was taken at light in June; this is the same month in which the moths of southern species such as *C. banksiaria* Le G., *C. melanoxysta* Meyrick, and *C. pini* Tindale make their principal appearances in temperate Australia.

In view of the general relationship evident between the males of the two species, the female of *C. cyclosticha* may also prove to be an apterous form.

IMMATURE STAGES OF *C. INKATA*

The larva drawn (fig. 3) was in the last instar, and measured 23 mm. in length with a head diameter of just over 3 mm. It was fixed in KAAD solution and preserved in alcohol. Larvae, apparently in the previous instar appear similar but tend to lack a rather conspicuous median dorsal process which is present on the posterior part of the abdomen of the adult larva.

The adult, actively feeding larva is smooth skinned and naked except for the inconspicuous basic hairs. The general colour is a dull green, an effect resulting from a series of roughly longitudinal lines of dark olivaceous green overlying a creamy yellow background. On the dorsum the longitudinal lines are more widely spaced and on the ventral surface the larva is pale all over. On the sides the dark lines tend to be broken up and to become an intricate pattern of marblings. The patterns are seemingly not alike on any two individuals; some tend to look maze-like and others show intricate designs. The anterior part of the head has a vertically placed, dark brown, almost black band, on each side; the posterior part of the head is pale creamy-yellow; the ocelli and the principal hairs on the head tend to be ringed with patches of the darker colours. The pro-legs are pale creamy yellow with the segmental margins and the parts facing forwards touched with dark brown. The abdominal process mentioned above, when viewed from the side, usually appears dark brown, or almost black; the anal claspers are pale creamy yellow but usually are blotched with a pattern in brown pigment.

The fully fed larva becomes shortened, rather stout and swollen, and loses its bright colours. It remains almost immobile for several days in a prepupal status before pupation takes place.

The pupa as drawn (fig. 5) is that of a male. It has a length of 11 mm. and a greatest diameter close to 4.5 mm. The pupa is chestnut brown in colour, is strongly cuticled, and has a shining or polished appearance. When drawn it was dead and had dried out; pupae which were still alive after 3¼ years could only be distinguished from it by the tongue test. The wing cases show obscure pittings between the veins; in addition the thoracic segments and middle portions of each abdominal segment are pitted with large and deep, circular impressions.

A female pupa is similar to that of the male and also is 11 mm. in length, but appears larger owing to the slightly greater diameter of the abdomen (4.8 mm.). Normal wing cases are present, no apparent reduction of wing is registered in the pupal integument. The antennal sheath is more slender than in the male and indicates lack of pectinations by a less complex patterning of the surface.

Since the moth itself is known only by these bred examples, nothing can be recorded of the habits of the free living prepupal larva, the type of shelter sought for pupation, or the time and circumstances in which the adult stage is passed. The pupal skin itself is stout and may be ant-proof. The female is strongly clothed in firmly adpressed spine-like hairs and in this respect seems to depart rather markedly from kindred species of *Chlenias* with normally winged females. The presence of these features may suggest that the moth is equipped for close association with honey ants, which throng the same trees. Aboriginal Australian beliefs regarding the larva of this moth, which are detailed below suggest they have observed a close association between ants and the larvae, even though their biological observations and deductions, in other respects, are rather wide of the mark.

The conditions in which the pupae were kept at Blackwood, 850ft. above sea level in latitude 35° S, were artificial, and in no close way resembled the climate of their home near Haast Bluff, at 2,000ft. elevation in latitude 23° 30′ S. It would therefore be unwise to draw any firm conclusions from their long endurance as pupae and from the emergence of some of the survivors after nearly three years in a dormant condition. Their persistence, however, does hint at one of the possible mechanisms of survival in the relatively arid surroundings of the MacDonnell Ranges.

Most members of the *Chlenias* group are so characteristic of the cool moist temperate areas of Australia that it was a distinct surprise to find this species in Central Australia and to find it so curiously adapted to its desert mountain environment.

It will be interesting to learn whether the species is confined to the mulga plains at higher altitudes within the MacDonnell Ranges, where rainfall, although very unreliable, is much higher than on the open desert plains to the south, or whether it has been able to extend its domain over the whole extent of the mulga covered lake plains of the desert interior of Australia. The presence at Broken Hill, on the south side of the belt of maximum aridity of what appears to be a separate species, *C. cyclosticha*, may suggest that *C. inkata* is not now able to live over the whole area of mulga desert but may be a relict form confined to areas of less confirmed aridity within Central Australia.

NATIVE BELIEFS ABOUT *CHLENIAS INKATA*

In Aranda mythology there is an association between the larvae of this moth, the mulga tree, the jeramba ['jeramba], honey ant (*Melophorus bagoti* Lubbock) and the lataruba ['lataruba] or spur-winged plover (*Lobibyx novaehollandiae*) leading to a strange admixture of observed fact, wrong association and false deduction.

The *Chlenias* larva is called kapadada ['kapada:da] or ngarda ['ŋarda] and it is regarded as the inkata ['iŋkata] or totemic "leader" (colloquially translated as "the boss") of the jeramba or honey ant. In their belief kapadada appears and causes little globules of honey dew to develop near the bases of the young phyllodes of *Acacia aneura* shrubs and trees. When one looks at the fresh growth, in August, against the sunlight, these little globules of sap, which natives call lutandja ['lutandja] glisten in the light.

They are a natural secretion from a gland near the base of the young phyllode. In Aranda belief, these globules, under the compelling force of the inkata, become larger, form along the stems and become lac scales (*Austrotachardia acaciae* Maskell), which yield sugar. These also are called lutandja. Jeramba honey ants gather the sap from the mulga phyllodes and the sugar of the lerp scales. They take it all below ground under the "direction" of the inkata, to feed their passive companions which become the living containers for the honey which they store. The natives do not associate inkata with any adult moth. They recognize that the larva goes into the ground near the ant nests and becomes a hard-shelled pupa. This they falsely associate with a stage of honey ant life.

Following the season of summer rains there is an appearance of sap in these mulga trees; at the same time the early stages of the life cycles of a whole suite of associated insects appear together. It is not altogether surprising that the aborigines with a less than complete interest in these insect life histories should incorrectly observe, and falsely entwine them into their beliefs.

There is said to be an Aranda song series which describes the part taken by kapadada, in a human form, in the development of the story of the jeramba or honey ant totem. The spur-winged plover man also plays an active part in the same story.

The Kukatja have similar beliefs about the *Chlenias* larva and call it ['pun:u 'parutji:ta] where ['pun:u] is a word meaning stick or tree. In the previously mentioned brief account of the botany of the Haast Bluff area (Cleland and Tindale 1959, p. 134) this Kukatja name was unfortunately given in error as ['pun:a 'parutji:ta].

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ON CENTRAL AUSTRALIAN MAMMALS

PART IV – THE DISTRIBUTION AND STATUS OF CENTRAL AUSTRALIAN SPECIES

By H. H. Finlayson, Honorary Curator of Mammals, South Australian Museum

Summary

The recent appointment by the Commonwealth Government of a full-time biological officer based on Alice Springs, with a major commitment in field work on mammals in Central Australia, draws attention again to the paucity of published information on the above heads upon which such work may be based. Under modern conditions the opportunities of making further contributions in this field are now much less favourable than formerly, owing to the growing rarity of most species and to the decline and changed interests of the aboriginal population, formerly one of the most prolific sources of such information. To augment the published data may well help to reduce this disability, and (departing from the planned sequence of this series of papers) the present contribution has been compiled with that end in view.

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PART IV—THE DISTRIBUTION AND STATUS OF CENTRAL AUSTRALIAN SPECIES

By H. H. FINLAYSON, Honorary Curator of Mammals, South Australian Museum

Fig. 1

CONTENTS

INTRODUCTION

The recent appointment by the Commonwealth Government of a full-time biological officer based on Alice Springs, with a major commitment in field work on mammals in Central Australia, draws attention again to the paucity of published information on the above heads upon which such work may be based. Under modern conditions the opportunities of making further contributions in this field are now much less favourable than formerly, owing to the growing rarity of most species and to the decline and changed interests of the aboriginal population, formerly one of the most prolific sources of such information. To augment the published data may well help to reduce this disability, and (departing from the planned sequence of this series of papers) the present contribution has been compiled with that end in view.

Its primary object is to give in summary form the relevant results of field work carried out by the present writer in a series of journeys in Central Australia in two widely separated periods, namely 1931-1935 and 1950-1956, during which a total of 27 months were spent in the country. The work of the earlier period was based chiefly in the south-western sector, in the great confluent Aboriginal Reserves of South, West and Central Australia and at a time when conditions there were still virgin and very favourable for the purpose, both the mammal fauna and the aboriginal population, being virtually undisturbed. In the later period the work was extended to districts further north and east, mostly in areas of pastoral occupation where aborigines, though still present, were detribalized in varying degree.

THE SOURCES OF THE INFORMATION SUMMARIZED

The information on each species is arranged in the following sequence:—

Aboriginal names;
General distribution;
Present status;
Material personally examined;
Other remarks;

and it embodies four categories of data, as follows:—

1. The Results of Personal Observation and Collecting.

2. The Results of Interrogation of Aborigines.

In recent years there has been in some quarters overseas a tendency to depreciate the value of the testimony of native peoples in such matters. Undoubtedly it is easy to be misled by casual methods of enquiry and possible to be misled even when the most careful methods are employed. But the systematic interrogation of aborigines in this country has yielded so much of value in the past, that no-one with a knowledge of the special conditions which obtain in Central Australia—where hunting was formerly the sole means of subsistence of the aboriginal population and followed with a marvellously cultivated technique—would suggest that this source of information could be neglected or even relegated to a subordinate position. Indeed had its value been recognized earlier and the much greater opportunities of 50 years ago seized and vigorously exploited, we would not have to deplore the great and probably permanent hiatuses which exist in our knowledge today. The information here presented has been obtained, whenever possible, by placing authentic specimens of the various known mammals in the hands of natives of both sexes and allowing them to freely examine and consider them, and the results so obtained have in many cases been cross checked by interrogation of widely separated groups.

In quoting native names of mammals, the intention has been to place a practical tool into the hands of others, rather than to make any formal contribution to aboriginal vocabularies, and for this purpose there are some advantages in partially anglicized forms rather than in those involving special phonetic symbols, which are little used or understood beyond anthropological circles. This applies to the names of native groups also, where I have for the most part used the name or names actually given me at the time. These do not always agree with the standard form adopted by Tindale (1940) but are usually close to one or more of the anglicized variants or alternatives listed by him. The approximate tribal boundaries as given by Tindale are no doubt also an approximate guide to the former currency of names of fauna, but under modern conditions where considerable infiltration, merging of minorities, or even complete replacement of aboriginal populations by neighbouring groups, has taken place, I have found that words may occasionally be heard in normal use far beyond these boundaries. Many of the vocabularies used by natives for fauna when these observations were made, had a dual basis owing to this merging or replacement of adjacent tribes and it has usually not been expedient, and sometimes not possible to make a complete separation of the original elements. This applies for instance to the Wonkanooroo and Dieri of the Lake Eyre Basin, Yankunjarra and Pitjanjarra of the Everard and Musgrave Range area, Arunta and Ilyowra of the Eastern Macdonnells, Tchingilli and Mudburra of Daly Waters, Walpari and Warramunga of the Davenport Range, and others.

The names recorded are those actually met with in the areas personally worked over and I make no attempt to compile lists by drawing on other sources such as Stirling and Spencer, Spencer and Gillen, Strehlow snr., Helms, Black, etc., partly because these vocabularies are readily available and partly because the identity of the species in question is sometimes in doubt. In a few cases where a name of special interest is quoted from another work, the source is indicated with it.

3. Locality Records of Material Personally Examined and Identified.

This is undoubtedly the most satisfactory type of evidence on which to base conclusions on distribution but unfortunately when material is scanty and the areas involved very great, it can give only a very inadequate version of the real state of affairs, and it is for this reason largely, that supplementary evidence from aboriginal sources has been considered on a comparatively lavish scale.

In the few cases where material has been available in large series only the peripheral or other significant records are quoted. The distribution of most species will be discussed in greater detail and mapped in a series of comprehensive papers now in preparation. For reasons indicated in the third paper of this series (1958) the treatment is for the present mostly at species level only.

4. Previously Published Records.

These are incorporated in the general statements on distribution, usually without specifying the source, except where the species has not been seen personally. In such cases, the essential data from the original publication is reproduced for the sake of completeness of account.

THE SUBDIVISION OF THE AREA

The term Central Australia has been used somewhat elastically to include not only the area within the political boundaries of the Federal Territory formerly so named, but also arid tracts of similar character adjoining it in the States of South Australia, Western Australia and Queensland, and there are necessary references also to the transition belt which separates the arid Centre from the well watered Torresian tracts to the north.

In the discussion of so large an area some subdivision is a convenience or even necessity. The excellent work of the Land Research Division of the C.S.I.R.O. will ultimately make this possible in terms of homogenous natural subregions but for the present purpose eight larger units are indicated, which though less uniform in character than these are wont to be and defined by more or less arbitrary boundaries, nevertheless show appreciable overall distinctness with some marginal overlapping.

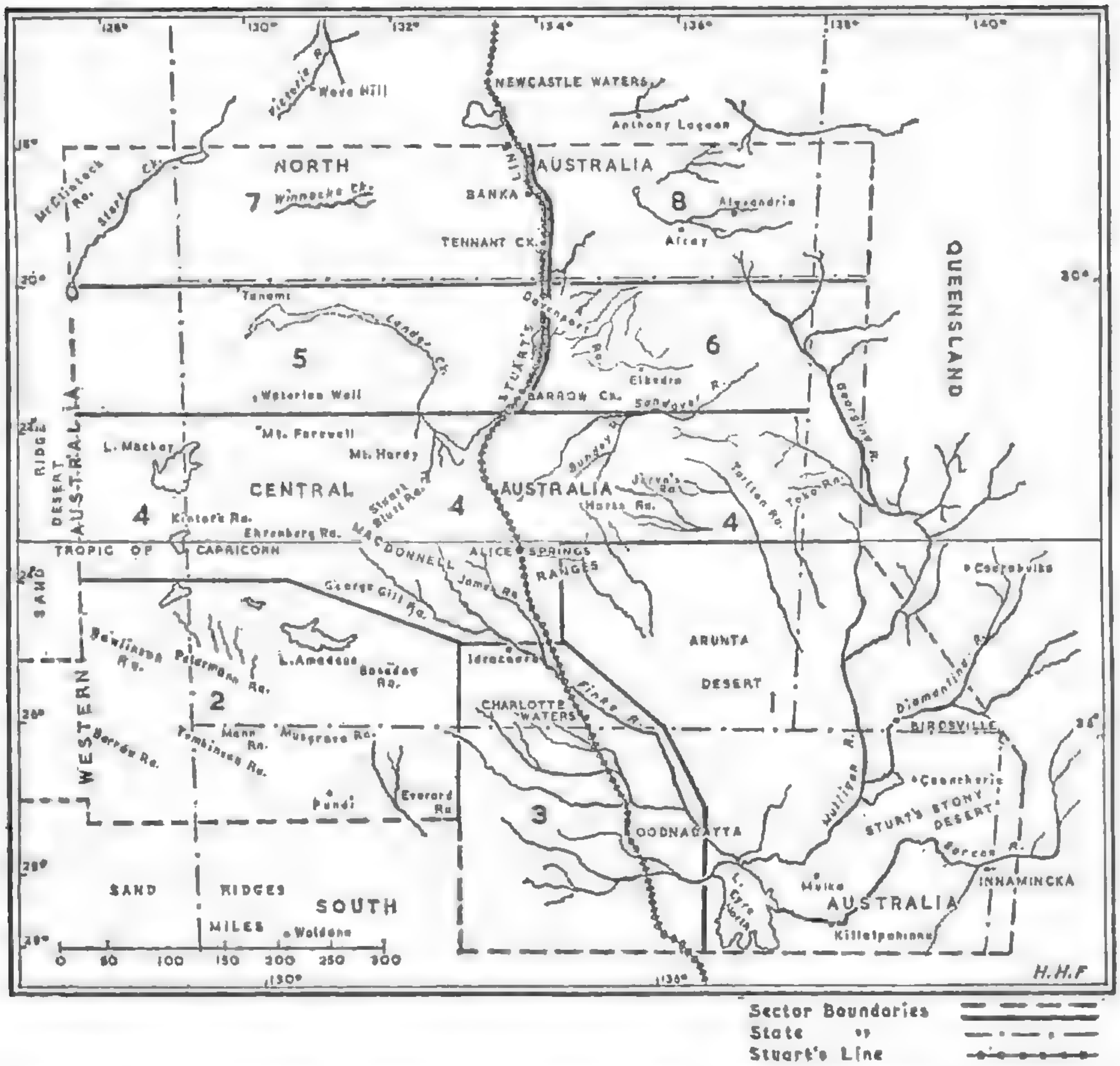

Fig. 1. Map of Central Australia and adjoining areas showing subdivision into eight sectors employed in text.

A useful primary division of the country may be had by reference to Stuart's Line, which lying on a general north-south axis undulates between the meridians of 133°-134° E. long. It marks the advance of J. McDouall Stuart to the north coast in his journeys of 1860-62 and is followed approximately by the Overland Telegraph and the Alice Springs-Port Darwin Highway. Especially in its northern portion the line divides the country into more or less distinct east and west moieties, the former being free from large sandridge areas, having generally firmer soils and more numerous and distinct drainage channels. This results in differences of vegetation, the most notable of which is a partial replacement of *Triodia* (spinifex), which is almost ubiquitous in the lower lands of the western division, by grass communities such as Flinders and Mitchell grass, in the east. As a consequence, pastoral occupation and its aftermath, is more extensive and of longer standing, in the latter.

The eight sectors (fig. 1) may be briefly indicated in general terms as follows:—

1. The South-Eastern Sector.

This includes (*a*) the eastern and northern portions of the Lake Eyre Basin in South Australia and the adjoining areas in south-west Queensland comprised in the drainage of the lower courses of the Barcoo River (Cooper Creek), and the Diamantina and Mulligan (Georgina) Rivers, and (*b*) the Arunta Desert.

It contains the lowest portion of the area mapped, some of it lying below sea level and its eremian features are more extreme than elsewhere. The rainfall is low and erratic, varying from 2 to 12in. per annum, but the eastern portion is periodically flooded by the overflow of rivers fed by remote catchments to the north-east. Large areas are occupied by sandridge and gibber deserts, where the vegetation is normally sparse and arboreal species largely suppressed.

This sector is markedly distinct from others, and some of its mammals are subspecifically differentiated, a pallid colouration being especially frequent.

Pastoral occupation is limited to the areas east of Lake Eyre and the Mulligan.

2. The South-Western or Amadeus Sector.

The Amadeus Basin with the highlands to west and south of it across the three State boundaries and including the Rawlinson, Petermann, Tomkinson, Mann, Musgrave and Everard Ranges and those on the 26° parallel of S. lat. in Western Australia, as an extension. This sector is a complex of granite, gneiss and quartzite hills with intervening mulga parks and thickets and some minor sandhill areas about the salt lake, and near its southern limit. Except for the Musgraves which rise to nearly 5,000ft. the hill systems are minor features and the creek channels which emerge from them are generally short lived. The long series of rangelets which extend deep into Western Australian territory on the 26th parallel are important from the point of view of distribution as they provide feasible lines of east-west diffusion for several species.

Pastoral occupation, chiefly with sheep, is limited to a small area in the north-east quarter and is not of long duration. The rest of the sector was originally part of the Aboriginal Reserve and is virgin country.

3. THE LARAPINTA SECTOR.

This is a South Central area lying between numbers 1 and 2 and including the lower drainage of the Finke and of the South Australian creeks which flow towards the west shore of Lake Eyre. It consists in large part of undulating gravelly plains, with areas of dense mulga thickets and frequent groups of residual tent-topped hills and eroded tablelands capped with desert sandstone. In the south the creek channels are lined with gidgee and myall (*Acacia* spp.) rather than with eucalypts. The whole area is pastorally held.

4. THE MACDONNELL SECTOR.

The ranges and enclosed plains from ca. 25° S. lat. (excluding those of sector 2) to 23° S. lat., including the Macdonnell Range system, the James, George Gill, Stuart Bluff, Reynolds, Jervois, and Tarlton, etc. A high, comparatively well watered and well vegetated tract, with peaks rising above 4,000ft. in the central portion. The arborescent plains vegetation is still largely acacia spp. but with an increasing element of eucalypt to the north. The lower, western portion merges with the Amadeus sector and the mulga (*Acacia aneura*) is the chief arborescent species there, but the eastern third is increasingly dominated by the very distinct gidyee (a complex of closely related species allied to *A. cambagei*) which forms characteristic uniform forests over hundreds of square miles towards the Queensland border.

Pastoral occupation involves the whole sector except for a small area near the western margin and in the central portion is of 80 years' duration.

5. THE LANDER SECTOR.

From the northern boundary of sector 4, to the former boundary of Central Australia and Northern Australia at 20° S. lat.; east to Stuart's line and west to the margins of the Great Sandridge Desert.

This is an area of general low relief with isolated hills and outcrops but no considerable ranges and with the single major drainage line of the Lander Creek as a central feature. Undulating plains of sandy loam are heavily scrubbed with mulga in the south-west, but elsewhere are lateritic, with lower shrubs and a considerable stunted eucalypt element alternating with triodia communities.

There are some minor isolated sandridge areas. Only a small portion of the sector is pastorally occupied and stocking of most of this is light and recent.

6. The Trans-sandover Sector.

The area east of Stuart's Line in the same latitude as 5. The north-western quarter is occupied by a characteristic series of quartzite and sandstone ranges (the Murchison and Davenport) with a great development of spinifex covered screes and plains and some thickets of the local "turpentine" (*Acacia lysiphloia*). A characteristic relict plant in the hills is the desert paperbark (*Melaleuca lasiandra*)[(1)]. Elsewhere are spinifex plains with mixed eucalypt-acacia parks merging in the north-east corner with Mitchell grass plains of the Barkly type.

The eastern portions of this sector contain the only areas east of Stuart's Line (apart from the Arunta desert) which have not been occupied for pastoral purposes.

7. The North-West Sector.

This is the western part of the lower transition zone between the Central and Northern Australian environments and extending from latitude 20° to 18° south; eastward to Stuart's Line and 100m. westward of the Western Australian border. The rainfall is higher (15-20in.) and there is an approach to a monsoonal climate, with increased summer humidity. The north-west angle includes some grass plain on Sturt Creek and the head of the Victoria River and along its eastern edge a belt of quartzite and sandstone rangelets and screes similar to the Murchison-Davenport area to the south.

The remainder is similar to the scrubby plains of the Lander sector but with a considerable increase in the eucalypts. The true mulga (*Acacia aneura*), the most characteristic of the Central Australian arborescent acacias, is now rare, its northern limit lying a little north of the 20th parallel of S. lat. in sectors 7 and 8. Pastoral occupation is confined to a relatively small area on the eastern boundary and in the north-west angle.

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(1) I am indebted to Mr. G. Chippendale of the Commonwealth Administration, Alice Springs, for the identification of these two plants.

8. The North-East or Barkly Sector.

The eastern half of the transition zone from Stuart's Line to 50m. east of the Queensland border. This consists largely of the so-called Barkly Tableland, characterised by treeless plains of black or ash grey soils with pure communities of Mitchell and Flinders grass, interspersed with islands of red soils carrying eucalypts and terminalias of northern facies, with triodia and under shrubs. The whole sector is occupied pastorally and portions of it have been stocked for 80 years.

FACTORS INFLUENCING THE PRESENT STATUS OF SPECIES

What I have recently written (1957) of the mammals of Upper South Australia is equally true of the Centre; namely that the question of what is extinct and what is barely extant is often impossible to answer with conviction, and where material records are scanty or lacking one must necessarily fall back on general inference and the testimony of the natives, where it is forthcoming.

In order to avoid the wearisome repetition of the same facts and inferences, species by species, it may be well to summarize very briefly the chief factors which have operated and are operating, to bring about the marked decline in numbers and territory, which with one or two exceptions only, has been the fate of all the Central Australian mammals.

1. Long Term Climatic Changes Involving Increased Aridity and Adverse Vegetative Changes.

In many cases this has prevented the development of large uniformly distributed populations and substituted a discontinuous type of occupation in widely scattered groups or colonies. Provided that sufficient mobility is retained or developed and that numbers do not fall so low as to prevent adequate gene flow between groups, this is probably a valuable adaptive mechanism tending towards perpetuation of the species. But there is ample evidence that several species known to science and probably still others known only to aborigines, did not develop this mobility or in other ways lagged in adaptation to the changing post pluvial conditions, and these were drifting towards extinction long before any of the human agencies next considered, were operative.

Such species were *Phascogale calura*, *Ph. penicillata*, *Bettongia penicillata* and perhaps *Trichosurus vulpecula*, *Leporillus apicalis*, and *Macroderma gigas*.

2. Aboriginal Hunting.

Aboriginal influence on the decline of the mammal fauna as a whole is probably a minor one and perhaps quite negligible, but it is not to be altogether discounted in the case of particular species. A good deal has been written and more implied about the possible effectiveness of some native food taboos, in conserving fauna. Whatever be the truth of that, it is clear that it only applies to the chief "game" species, and it seems probable that an active hunting population, even though in very small numbers, may have hurried along the exterminating process, in those cases where the range occupied by the animal was very restricted and its population thin.

Some of the hunting methods of the blacks, especially the "fire-trap" technique, in which large areas of vegetation are burnt out, must have borne very hard on non-burrowing species, like *Bettongia penicillata*.

3. European Occupation and Pastoral Exploitation of the Country.

This is no doubt a major cause of decline and perhaps the chief one. Although the total numbers of ungulate stock seem relatively small when compared with the area occupied, the constant movement to and from watering places causes a multiplication of a disturbing factor with which many native species, especially the surface nesting forms, cannot cope. It has constantly been observed on stocking virgin country, that many native species disappear long before any question arises of competition for food. In many cases no competition for food is involved at all and in the case of *M. rufus*, which from its grazing habit might *a priori* be expected to furnish an exception, one finds the greatest tolerance—kangaroos in large numbers coexisting with domestic stock about the same waters.

The red kangaroo (and to a lesser extent the hill kangaroo, *M. robustus*) is of special interest in this connection as furnishing the only example of a native species which may have been favourably influenced by pastoral operations (infra) and which in some districts has shown marked increase in numbers in spite of restrictive measures.

Pastoral occupation is of greater extent and longer duration east of Stuart's Line than west of it and this fact has to be borne in mind when considering present-day distribution—several species such as

Isoodon auratus, *Perameles eremiana*, *Bettongia lesueuri*, and *Lagorchestes hirsutus*, which are much better represented in the western division, may originally have been more uniformly distributed and may perhaps even have passed east of the Queensland border, where today they appear to fall short of it.

Active persecution by the white community is limited to two species—the red kangaroo and the dingo—and in neither case has survival, or even general numerical status, been seriously threatened as yet.

4. Introduced Pests.

Here and there introduced ungulates have escaped and built up considerable feral populations in virgin territory which have had a deleterious effect on native fauna over small areas. Far more important, however, are the three major scourges, the rabbit, the fox, and the feral house cat, which together have had an effect in certain districts only to be described as catastrophic; the first by competition for food plants and the two latter by direct predation.

At present the fox and rabbit are chiefly concentrated in the southern sectors where a vain hope was entertained that the latter might buffer the effect of the fox on the native mammals. But in the last 25 years, the region comprised by the Everard, Musgrave, Mann and Tomkinson Ranges—one of the most beautiful hill tracts in arid Australia, largely unoccupied by white man and with many of the attributes of a natural sanctuary—has been stripped of most of its smaller species by the increase of the fox there. The work of the fox is often done with remarkable speed and it seems probable that the colonial type of distribution of so many marsupials, is particularly vulnerable to its attack—small groups being systematically hunted out of existence, before they have time to develop a protective mechanism.

The extent to which the fox succeeds in occupying the sectors further north is of vital concern in the future of Northern Territory mammals. Experience in Western Australia suggests that if left to itself it may eventually work right through to the north coast.

The feral domestic cat which is widely spread in Central Australia is also no doubt a destructive force of some magnitude here as elsewhere; but as it preceded the white man in the Centre by several decades at least, and the rabbit and the fox by a still greater interval, without producing comparable effect to the latter, it is presumably of less virulence.

5. Epidemic Diseases; Poisoning Through Natural Agencies; and Heat Apoplexy.

These have all been observed to cause death in the larger macropods, but do not appear to act as major causes of loss in Central Australia.

SYSTEMATIC PRESENTATION OF THE DATA ON NAMES, DISTRIBUTION AND STATUS OF SPECIES

ORNITHODELPHIA

Tachyglossus aculeatus Shaw 1792

Wonkanooroo (*s. lato.*), *Inappa, Inniwallinga*; Pitjanjarra (*s. lato.*), *Tchilkamutta, Tchirilya*; Arunta, *Inarlinga* (widely used); Ilyowra, *Yunaba* (widely used); Warramunga, *Wajingurri* (*Wajinga*); Worgaia, *Nilliyilloo*; Tchingilli, *Keelyilli, Ngingulda*; Mudburra, *Yenodin*; Alowa, *Oolbulla*.

Ubiquitous and sometimes quite plentiful, especially in rocky hills; has one of the highest survival rates amongst Central mammals even in fox infested country.

Material examined is from the Musgrave Range in sector 2 and from the George Gill Range, Napperby Hills and Frazer River in sector 4.

On the former occurrence of *Ornithorhynchus* in Central Australia, the possibility of which has been canvassed from time to time, I have obtained no evidence in support.

DIDELPHIA

DASYURIDAE

Dasyurus geoffroyi Gould 1841

Wonkanooroo (*s. lato.*), *Yikowra*; Pitjanjarra, *Pulchida* (*Partjada*); Yankunjarra, *Keenika*; Kukatja, *Tajadi* (widely used); Arunta, Ilyowra, *Achilpa* (widely used); Warramunga, *Winnijungoo*.

Further north the following names are used primarily for *D. hallucatus* (infra): Tchingilli, *Jobodo;* Alowa, *Wanumbeera*; Mara, *Woonyaboonya*; Larrakia, *Luali*.

Formerly widely distributed and plentiful over a large part, or possibly over the whole of the central area, but now a rare and apparently vanishing form. I have recent accounts of it surviving in sectors 4, 6, and 7, but it seems to have completely gone from the Everard-Musgrave Range area which yielded the only material examined. This indicates a small phase of *D. geoffroyi* with some modifications tending superficially towards *D. hallucatus* so that separation from that species by interrogation is uncertain, and it is possible that *D. hallucatus* infiltrates the transition zone of sectors 7 and 8. It is significant however that Glauert (1933) records *D. geoffroyi* in the Sandridge Desert about 50m. from the western boundary of sector 7.

Material examined is from Chundrinna and Walthajalkanna to the north of the Everard Range. Spencer had material from Alice Springs and Crown Point.

Phascogale calura Gould 1844

The inclusion of this species in the Central fauna still rests on the original record of Spencer of specimens taken by Gillen at Alice Springs in the Macdonnell Range in 1896. I have been unable to obtain any further satisfactory information upon its status, and it would appear to be a relict form confined to the range or at least with a very restricted distribution. If it still exists it must be excessively rare. One of the original specimens has been examined, as well as one from the Mount Lofty Range of lower South Australia.

The related species *P. penicillata* Shaw has a northern race *pirata* Thomas, originally based upon the South Alligator River in Arnhem Land, in a high rainfall area. Glauert, however (1933) records it from the Sandridge Desert of Western Australia at about lat. 21° 50′ S. This corresponds to the south boundary of the Lander sector about 200m. east, and it may therefore extend into Central Australian territory.

Phascogale (Pseudantechinus) macdonnellensis Spencer 1896

Since the original series was taken at Alice Springs in the Macdonnell ranges, I have had it from the Basedow Range area in the Amadeus sector of the South-West in 1937 and again in 1939, and it was recorded also from the Granites south of Tanami in the Lander sector, in 1952. It is certainly not a common form at the present day but its true status is obscure.

Material examined comprises part of the original collection, the Basedow Range specimens and a long series from localities unfortunately not further specified than as from "Central Australia".[1]

The related form *Ph.* (*Pseudantechinus*) *mimulus* Thomas 1906 is apparently still represented solely by the type specimen from Alexandria in sector 8.

Phascogale (Planigale) ingrami Thomas 1906

The original record of 5 specimens from Alexandria in sector 8, is apparently still the only one for this species, in the area here considered.

Dasycercus cristicauda Krefft 1867

Wonkanooroo, *Mudagoora*; Pitjanjarra, *Muritcha*; Arunta, Ilyowra, *Ampurta;* Walpari, *Narloodi, Tajinna.*

A widely distributed and formerly very plentiful species, with records in all the sectors except 8, but especially characteristic of the south Central areas. The northern limit is at about 19° S. lat. but in the adjoining tracts of Western Australia, Glauert (1933) records it from 18° S. lat.

It tends to concentrate upon sandridge areas and in 1931-32 after a period of scarcity was in large numbers about the lower Diamantina and Barcoo in the eastern part of the Lake Eyre Basin, and from 1932-35 was found to be one of the most plentiful small mammals in the Amadeus sector. At the present time it is almost unknown in the latter sector and is everywhere much reduced but has been obtained during the last five years from points as far apart as Yuendumu and the Tarlton Range.

Material examined is from the eastern part of the Lake Eyre Basin, where the very distinct pallid phase known as *D. c. hillieri* Thomas occurs; from sand areas adjoining the Everard, Musgrave, Mann, Tomkinson and Basedow Ranges in sector 2; from Yuendumu near the boundary of sectors 4 and 5; from the Tarlton Range in the far east of sector 4; from Tennant Creek in sector 7; and from the Canning Stock Route in the Sandridge Desert of Western Australia.

(1) Much early material examined by me is labelled baldly as from "Central Australia", which at the time seems to have been regarded as a sort of torrid Ultima Thule, neither capable of, nor needing, more detailed localization. This leads to an exasperating loss of many valuable records.

Dasyuroides byrnei Spencer 1896

Wonkanooroo, *Kowari.*

The locus of the type series was Charlotte Waters in sector 3 and of the later subspecies *D. b. pallidior* Thomas 1906, Killalpaninna in sector 1. Formerly it had a considerable range in the eastern part of the Lake Eyre Basin and was well known to the blacks and many settlers by the above name, but I have been unable to trace it in other parts of the Centre, several reports of it being due to confusion with *Dasycercus.*

At the present time it is one of the rarest of the Dasyuridae, but retains a very tenuous hold on the eastern part of the Lake Eyre Basin, and has been taken recently at Birdsville.

Four specimens only have been examined and these are imperfectly localized, as from "Central Australia".

Sminthopsis crassicaudata Gould 1844

Wonkanooroo, *Nilee.*

This species periodically undergoes great increase in the eastern part of the Lake Eyre Basin in sector 1, whence most of the material here examined has come. It represents the long legged, long tailed, pale coloured local phase, *S. c. centralis* Thomas 1902 which Tate (1947) proposes to separate from *crassicaudata* and treat as a subspecies of *S. macroura* now raised to specific rank. I have discussed in detail (1933) the evidence for regarding *crassicaudata* and *centralis* as subspecifically related, based on the examination of a large series from intermediate localities.

Elsewhere in the Centre it is less well known and is apparently not subject to great fluctuations in numbers.

Records are available from the Lake Eyre Basin in sector 1; Arckaringa in sector 3; Mentibee in sector 2; Macdonnell Ranges and the Bundey River drainage in the north-east of sector 4; Yuendumu in the north-west of sector 4; and Willowra in sector 5.

Material from all these points has been examined.

Sminthopsis hirtipes Thomas 1898

The type was from Charlotte Waters in sector 3 and it has since been obtained in the Lake Mackay area in the far west of sector 4, and Glauert (1933) has recorded it from near the Warburton Range in the western extension of sector 2 and at Well 29 on the Canning Stock Route of the Sandridge Desert. The latter specimens have been examined.

Nothing is known of its status.

Sminthopsis larapinta Spencer 1896

Wonkanooroo, *Melatjhani.*

The type locality is at Charlotte Waters in sector 3, and it has been taken also in the eastern portion of the Lake Eyre Basin in sector 1 both in South Australia and Queensland; in the Macdonnell Ranges and between the Bundey and Frazer rivers in sector 4, and at Tanami in sector 5—the last record by Glauert (1933). It has latterly been considered that *S. stalkeri* of Alroy and Alexandria is a subspecies of *larapinta* and if this be so, it is likely that the distribution of *larapinta* covers most of Central Australia.

Like *S. crassicaudata centralis, S. larapinta* is periodically very plentiful in the eastern part of the Lake Eyre Basin, but is very sparse elsewhere.

Tate (1947, p. 123) states that I have questioned the distinctness of these two species. This however is very far from being the case, and in 1933 I listed the obvious points of distinction both external and cranial, which separate them.

Material examined is from the first four localities quoted.

Sminthopsis murina constricta Spencer 1896

This somewhat cryptic form still rests I believe, on Spencer's original specimens from Oodnadatta in sector 3 and Alice Springs in sector 4.

Sminthopsis psammophila Spencer 1895

The type which is still unique so far as published records go, is from the vicinity of Lake Amadeus in the south-west sector.

I append a number of aboriginal names for *Sminthopsis* like animals which are insufficiently characterized to be assigned to any of the above species with confidence: Yankunjarra, *Walbunba;* Arunta, *Munyoolba*; Ilyowra, *Bunyilba, Annuljalu*; Walpari, *Kunnakulumbi, Tchungunba*; Tchingilli, *Yarrukaddi;* Mara, *Maloweea.*

Antechinomys spenceri Thomas 1906

Yankunjarra, *Pitchi pitchi*; Arunta, Ilyowra, *Arrajunuta*.

Records are available from Oodnadatta and Charlotte Waters in sector 3; from the Everard, Mann and Musgrave Ranges and Wollara, in sector 2; from the Macdonnell Ranges, upper Sandover River, Bundey and Ooratipra Creeks, and the Tarlton Range in sector 4; and from Tennant Creek in sector 7.

Wood Jones (1923) wrote of its excessive rarity and this may be true of the Lake Eyre Basin and of the western district of South Australia, where he sought it, but from 1932-35 in the Everard and Musgrave Ranges and from 1953-56 in the eastern part of sector 4, I found it fairly plentiful—much more so than any of the *Sminthopsis* species, and in the latter period it was frequently being brought into homesteads at night by cats.

Material has been examined from all the above localities and a specimen also from the Murchison district of Western Australia, taken in 1928, 50 miles north of Meekatharra. This appears to be the most westerly record and is nearly 600 miles north-west of Rawlinna whence it is also claimed.

Myrmecobius fasciatus Waterhouse 1836

Yankunjarra, *Wulpoorti* (*Wailburdi*).

Locality records are from the south and west of the Everard Range; south of the Cavanagh Range and north and west of the Rawlinson Range, all in sector 2 or its western extension.

In these localities it was formerly quite plentiful, but I know of no material having been taken since 1933 and as the fox has greatly increased in this sector since that time, its chances of survival are not good.

Material examined is all from the Everard Range district. The local form is *M. f. rufus* Wood Jones 1923.

PERAMELIDAE

Thalacomys lagotis Reid 1837

Wonkanooroo, *Thulka*; Dieri, *Kapita*; Pitjanjarra (*s. lato.*), *Talgoo* (*Djalku*) (widely used), *Ngynoo*; Arunta, Ilyowra, *Anunga*, *Ayoorta*; Walpari, *Yarninga*; Warramunga, Wombaia, *Warrigiddi*; Tchingilli, *Yalbo urru*.

Formerly one of the most plentiful and universally distributed of Central Australian mammals, with a heavy concentration of population in the south-west sector and central portions of sector 4. Locality records cover all sectors except 8 where the Barkly Tableland was apparently never occupied. The species formerly extended much further north than is generally realized and there is good evidence of it 30 years ago at Lulwa about 50 miles north of Newcastle Waters.

At the present time it is rapidly being reduced to the status of a rare form and has been completely eliminated from much of the south-west sector in the last 25 years, by the fox. It still occurs in small numbers in the ranges of the 26th parallel in Western Australian territory; in the Western Macdonnells; in the Lake Eyre Basin; and at one or two points in sectors 6 and 7.

The greater part of the material examined is from the south-west sector, but material from peripheral localities includes (1) Pundi in the sandhill belt south of the Musgrave Range; (2) Blackstone and Warburton Ranges on the 26th parallel in Western Australia; (3) Sturt Creek in the north-west; (4) Tennant Creek in the north centre; (5) Frazer River in the east of sector 4; (6) Cooncheri and Birdsville in the south-east of sector 1.

Thalacomys minor Spencer 1897

Wonkanooroo, *Yallara*; Urabunna, *Urpila* (*fide* Stirling and Spencer).

The species is known from two districts only, the original form as described by Spencer coming from near Charlotte Waters in sector 3, and a subspecies *T. m. miselius* described in 1932, from Cooncheri, Mungeranie and Kopperamanna on the lower Diamantina and Barcoo in sector 1.

From the type locality in sector 3 the species seems to have completely disappeared and I know of no records of it since 1904. The subspecies *miselius* probably still persists in the Lake Eyre Basin in vanishingly small numbers.

The material examined comes from all four of the above localities, but much more plentifully from sector 1.

It has been debated whether the eastern form *T. m. miselius* may not be identical with the earlier described form *T. leucura* Thomas 1887 which is known only by a single immature and unlocalized specimen. Tate (1948) who alone has examined the types of both *leucura* and *miselius* dissents from this, so that there are no grounds at present for claiming the former as a Central Australian species, though it may well have been so.

Isoodon auratus Ramsay 1887

Pitjanjarra (*s. lato*), *Wintarro, Nyurloo.*

These two names are well differentiated from *Perameles eremiana* by natives who knew both animals as living sympatric species. Those which follow may apply to either:—

Nadadjara, *Makoora*; Kukatja, *Poodoojooroo*; Ilyowra, *Yiwurra, Taich*; Arunta, *Yiwurra, Arkoora*; Walpari, Warramunga, *Bukquroo*; Mudburra, *Bukquroo, Myarin*; Tchingilli, *Butgoolo, Kulwarri.*

There is no doubt that *I. auratus* was formerly a very widely distributed form in Central Australia, wherever sandy spinifex tracts occurred in considerable expanse, as is particularly so west of Stuart's Line. Where material is not available, however, it is often impossible to be sure from the accounts of natives whether this species, or *Perameles eremiana* or both are being indicated. In districts such as the south-west sector in the period 1932-35 where the two occurred sympatrically there was no confusion in nomenclature, but in the pastoral districts east of the line, where bandicoots of either kind had not been seen for thirty years or more, names were used less precisely. All that can now be said is that one or other of these two species, and frequently both, probably occurred in suitable habitats over the whole of Central Australia.

I. auratus survives in considerable numbers in the western part of sector 4; the adjoining part of sector 2 and in sectors 5, 6 and 7. In the more southerly districts it is rare or absent. Its reduction in the southern part of the south-west sector has been very steep in the last 25 years.

The material examined comes from the lower Barcoo River in sector 1; from Pundi and Koonapandi south of the Musgrave Range and from the Everard Range in sector 2; from Lake Mackay in sector 4; from the Granites south-east of Tanami in sector 6; from several points on the Canning Stock Route in the latitude of sectors 4, 5 and 7 but further west in the Sandridge Desert; and from Tennant Creek in sector 7.

The "*Perameles obesula*" recorded by B. Spencer (1896) from the Burt Plain and Tennant Creek is no doubt to be referred here—*I. obesulus* and *I. auratus* are closely, perhaps subspecifically, related.

Perameles eremiana Spencer 1897

Pitjanjarra (*s. lato*), *Wallilya*, *Nginana* (*et vide supra*).

Spencer's original material upon which the species was founded came from north-east of Charlotte Waters in sector 3 and from the Burt Plain in sector 4. Other records are available from south of the Musgrave and Mann Ranges, and north of the Rawlinson Range in sector 2; from the Warburton Range area, west of this (Glauert 1933); and from near the Granites below Tanami in sector 5. Although no definite records are available east of Stuart's Line, some material collected by Winnecke, which has been examined, should probably be so placed, and it is almost certain that some of the native names of mixed application, which are listed above with *I. auratus,* relates to *P. eremiana.* Possibly a former sympatric occurrence of the two species over the greater part of Central Australia, would be a justifiable inference.

In 1932-35 it was a well known and fairly plentiful species in the south-west sector, though less numerous than *I. auratus,* but is now absent or rare in this fox infested quarter. It still persists in sectors 5 and 7.

Material examined comes from south of the Musgrave and Mann Ranges and from unspecified localities in "Central Australia".

Sanger (1882) records "*Perameles fasciatus*", from the lower Barcoo River in sector 1, but the interpretation of this is doubtful. I have not been able to gather any good evidence of the presence of any of the banded bandicoots in the areas here dealt with.

Choeropus ecaudatus Ogilby 1838

Pitjanjarra (*s. lato*), *Kunjilba.*

Locality records exist for the lower Barcoo in sector 1; from south of the Musgrave Ranges in sector 2; from Charlotte Waters in sector 3; from Ryan Well in sector 4; and from Barrow Creek in sector 5.

If the animal still exists it must now be excessively rare. It is possible that some references to it are entangled in the incompletely specified names given under *I. auratus* and *P. eremiana,* as its habits are quite similar to those of the latter, but the only clear cut account of it which I have had in personal interviews was from elderly Pitjanjarra men in the Musgraves. They distinguished it satisfactorily from Wallilya by the longer ear and the peculiarities of its manus and pes. They had not seen it since about 1926 and spoke of it in general terms as a southern form.

Of the four specimens examined only two are definitely localized in Central Australia and these are from Ryan Well and the lower Barcoo respectively.

Notoryctes typhlops Stirling 1889

Pitjanjarra (*s. lato*), *Eecharricharri* (*Itjaritjara*); South Arunta, Urabunna, *Oorquamata* (Stirling); Walpari, *Mundawuljiwulji.*

The species is recorded from the Basedow range area, from east of Mount Conner, and south of the Mann, Musgrave and Everard ranges in sector 2; from Charlotte Waters, Idracowra and Crown Point in sector 3; from south of the George Gill Range, Hermannsburg and Arltunga in sector 4; from the Wauchope area south-west of Tennant Creek in sector 5; and from the Sturt Creek in sector 7.

The centre of distribution in the latitudes here considered seems definitely to be in the south-central and south-western districts of sectors 2 and 3; the bulk of the material and most of the records, originating there. Elsewhere, over large areas, especially east of Stuart's Line there seems to be no aboriginal knowledge of it at all In 1931 I found that keen Wonkanooroo hunters who had spent 40 years between the lower Diamantina and Barcoo and the southern portion of the Arunta Desert knew nothing of it, nor did their women, but Johnston (1943) gives some credence to a report that an animal called Kakoma (by the ? Wonkadjura) in south-west Queensland may be this species. The Arltunga record is based on statements of R. T. Maurice (1903) who knew the animal well in the south-west sector and in lower South Australia and the Wauchope report I obtained from a group of Walpari in 1954 who recognized and named the animal from a skin.

At the present time it persists in some numbers in sectors 2 and 3, but elsewhere, if present, must be a very rare form.

Much of the material examined is only vaguely localized as from "Central Australia", though there is contributory evidence that this meant sectors 2 or 3. Of the records quoted above all are supported by material, except that from Arltunga and Wauchope.

PHALANGERIDAE

Trichosurus vulpecula Kerr 1792

Pitjanjarra (*s. lato*), *Wyoota* (very widely used), *Mungawyuroo*; Arunta, *Andunya*; Ilyowra, *Undinna*; Walpari, *Tchungba*; Warramunga, *Marrabun*; (?)Worgaia, *Wamburra*; Wombaia, *Gowngar*; Mudbarra, *Junganar*; Tchingilli, *Takooladji*; Mara, *Kudjani*.

This ubiquitous animal is notable in the Central Australian fauna, as being the solitary representative of a family, elsewhere often rich in species. The locality records involve all sectors, but there are large areas in the Barkly Tableland, Lander basin, and the north-west sector, which it may never have colonized.

Formerly it was an extremely abundant animal over wide areas, and as late as 30 years ago, one of the chief food species of the natives in some districts, but now suffering a decline which in most parts has reduced it to the status of a rare form. In the field work of 1932-35 it was found to be very plentiful and easily obtained in the south-west sector, where a portion of its population was living a semi-terrestrial life and sheltering in tchungoo and rabbit warrens. This innovation has probably been terminated by the increase of the fox, but it still persists in widely separated "pockets". I have recent reports of it in the Blackstone Range in the western extension of sector 2, and in the Central Macdonnell Ranges, and Arthur and Plenty Creeks in sector 4.

The collapse of its population, especially in sector 4 where there is a great development of eucalypt avenue woods along the streams and the fox is not a serious menace, is difficult to account for. In spite of its apparent success in occupying large areas of country, it may be that a long term climatic factor has been slowly telling against it.

The material examined is from the lower Barcoo in sector 1; from numerous points north and south of the Musgrave Ranges, south of the Mann Range, Everard Range area, and Wollara in sector 2 and west of that in the Warburton Range; from the Lake Mackay area of sector 4, and from west of sector 5 at Well 43 in the Sandridge Desert.

PHASCOLOMYIDAE[1]

There appears to be no worthwhile evidence, aboriginal or otherwise, of the occurrence of any member of this family as a recent

(1) *Post Scriptum:*

In preparing the above note, I had overlooked the fact that in correspondence with the late Dr. Macgillivray, of Broken Hill, he had informed me that wombats still survived in small numbers in the Paroo River and Tibooburra districts of New South Wales, as late as 1923.

species, within the area here treated of, but a passing reference to it is called for by reason of the local reports which have been made from time to time, of wombat burrows about the main ranges of sector 4. These are probably based on old tchungoo warrens, with the holes enlarged by weathering and coalescence.

The most northerly extension of the family is given by *Lasiorhinus latifrons* which, as a recent species in South Australia, reaches only to ca. 31° S. lat. and about 600 miles south of Alice Springs. In Queensland, however, the relict population which has been named *L. latifrons barnardi* Longman occurs in about the same latitude as the Macdonnell Range, at a point some 900 miles east of the same town.

MACROPODIDAE

Macropus rufus Desmarest 1822

Dieri, *Tchukooroo*; Wonkanooroo, *Koongarra*; Pitjanjarra, *Marloo* (*Merloo*) (very widely used); *Arunta, Okirra* (Stirling); Ilyowra (south) *O arra*; Ilyowra (north) and ? Worgaia, *Alarra*; Walpari, Warramunga, Tchingilli and Wombaia, *Yow wirri* (very widely used); Mudburra, *Wangurra*.

Locality records for the red kangaroo cover all eight sectors and it extends far beyond the boundaries of the area here considered, to the south, west and east, and considerably beyond the northern boundary.

In the last two decades the density of its population has undergone an enormous increase in the central parts of sector 4, which is sometimes attributed to the artificial proliferation of surface waters, through pastoral agency. Whatever its cause it should be noted that the increase has merely accentuated a natural distribution pattern, shared by several other species, which are not influenced by this factor. Within a south-central area of about 20,000 square miles which lies to the north of the main mass of the Macdonnell Ranges, it is safe to assume that several millions have been killed since 1945.

Its numbers fall away very steeply to the east, west and north of this area, and somewhat less so to the south. Normally it is absent from the major sandridge areas and from the larger expanses of spinifex flats, but its phenomenal mobility enables it to exploit all types of country when favourable changes in the vegetation occur.

The material examined is copious, the peripheral localities represented being: to the west, the Warburton Range; to the south-east, Tcherrikooninyee, west of Sturt's Stony Desert between the

Diamantina and Barcoo Rivers; to the east, Pituri Creek on the Queensland border of sector 4; north, Banka Banka in sector 7; and north-east, Alexandria on the Barkly Tableland.

Macropus robustus Gould 1842 vars.

Pitjanjarra (*s. lato*), *Kunula* (*Kunala*) (very widely used); Arunta, Ilyowra (south), *Arrunga*; Ilyowra (north) and ? Worgaia, *Areenin*; Warramunga, *Maradjee*; Tchingilli, *Walabunmurra*; Mudburra, *Joodama*; Mara, *Kirimbu*.

Phases of this species are almost as widely spread in Central Australia as *M. rufus*, and its extension beyond its borders even greater, reaching almost to the coast in the north and east. It occurs wherever the elected habitats of rocky ranges—often of very insignificant dimensions—are to be found, but has probably always been absent from sector 1, and at the present time is virtually so from sector 3.

In the last 60 years the euro has undergone marked recessions in some parts of the country, particularly in the eastern third of sector 4 and in the southern tablelands of sector 3, but in all the major hill systems it maintains large populations, some of which, in the Macdonnell Ranges, have shown an increase parallel with that of *M. rufus*, though on a less spectacular scale.

Much material has been examined, the marginal collections coming from the Everard Range in the south; Cockatoo Creek in the north-west; Banka Banka and Newcastle Waters in the north and the Tarlton Range in the east.

During the course of this work, some skulls of the very distinct species *M. antilopinus* Gould have been examined, which are attributed to Banka Banka in sector 7, which is about 200 miles south of its normal range and in anomalous conditions. The same collection has skulls of *M. rufus* labelled as from the Adelaide River, which is an equally anomalous record in the opposite direction. As I have been unable to confirm either of these apparent extensions of range by my own field work, I am assuming, pending further evidence, that the localities of these skulls have been transposed.

Petrogale lateralis Gould 1842

Pitjanjarra (*s. lato*), *Warroo* (very widely used); Arunta, *Arrawa*; Ilyowra (south), *Arrawa, Kulara*; Ilyowra (north) and ? Worgaia, *Rance*; Walpari, Warramunga, *Wagularri*.

The major distribution of this rock wallaby is in Western Australia, whence it overlaps the Centre to about the Queensland border in sector 4. The north limit is at about 20° S. lat. just below Tennant Creek in sector 7, and in the south it extends to the limit of the belt of granite peaks south of the Musgrave Range at about 27° 30′ S. lat.

The distribution pattern is somewhat similar to that of *M. robustus*, but is less extensive and more discontinuous—many ranges and rangelets either having no colonies at all or being occupied only intermittently with long periods of vacancy between. Its chief populations are in sectors 2 and 4; it is absent from sector 1 and there are no records for the greater part of sectors 7 and 8.

Its numerical status at the present time is much reduced from what formerly obtained, but whether it is precarious or not is difficult to determine, owing in part to its normally migratory and incomplete occupation of the country. In 1932-35 it was one of the commonest mammals of the south-west sector with swarming populations in many of the rocky outliers of the main ranges. Today, although it still persists at scattered points there, it is a comparatively rare form. In sectors 4 and 6 it is currently reported in small numbers from several widely separated localities in the Macdonnell Range, the Davenport Range, and the drainage of the Sandover and Bundey Rivers. Oddly enough it persists in some numbers on Chewings Ridge on the outskirts of the town of Alice Springs, where it now has to contend with the tourist and pea rifle.

A long series of specimens has been examined, and the outlying localities represented are; Barrow Range and Everard Range in sector 2; Cockatoo Creek on the boundary of sectors 4 and 5, and between the Sandover and Frazer Rivers in sector 4, east of Stuart's Line.

There is at present no satisfactory evidence of any other species of *Petrogale* in Central Australia. Tate (1952) records a form of *P. inornata* from the Mount Isa district of west Queensland and it is possible that this diffuses across the border into the eastern areas of sectors 4 and 6, from which very little material has been examined.

The nearest colonies of *P. xanthopus* in South Australia and Queensland lie far to the south and east, with no overlap with the central *lateralis*.

Onychogale lunata Gould 1841

Pitjanjarra (*s. lato*), *Towala* (*Towalpa*), *Unkudda*; Arunta, *Yiwutta*.

Another predominantly Western Australian species with an overlap in Central Australia, but less extensive than that of *P. lateralis*. The locality records listed involve sectors 1, 2, 3 and 4 only, with a northerly limit at about 23° S. lat.; sector 1, Lower Barcoo Creek; sector 2, Everard Range, Officer Creek, south of Musgrave, Mann, Tomkinson and Basedow Ranges; west extension of sector 2 in the Cavenagh and other ranges on the 26° parallel; Macumba Creek area of sector 3; and in sector 4, north of Ehrenburg Range, Red Bank, Bond Springs, Alice Springs, Huckitta and west of Tarlton Range; the two last, east of Stuart's Line.

At the present time this is one of the rarest of Central Australian macropods, but is still extant in sectors 2 and 4 at least and one was killed between the Tarlton and Jervois Range as late as 1956. In 1932-35 it was still being reported and occasionally obtained by natives in the south-west sector, but I have personal knowledge of only two specimens taken in that period.

Material examined is scanty, and comes from the Everard Range; between the Everard and Musgrave Ranges; the Cavenagh Range and Bond Springs.

Onychogale unguifera Gould 1841

Mudburra, Tchingilli, Warramunga, *Tchuuma* (very widely known); (*Wakunja, Wagunyamenzi*; descriptive nicknames of the same peoples).

A north Australian species extending east from the coast of the Kimberley Division in Western Australia to the Pacific coast of Cape York Peninsula in Queensland, and diffusing south to about 20° S. lat. in the area here considered. There are records in sector 7 from Banka Banka, and the lower course of Sturt Creek.

It is not in large numbers on this southern fringe of its distribution, but is well known in several districts there.

Material examined is from north of Banka Banka and beyond.

Lagorchestes conspicillatus Gould 1842

Kukatja, *Oqualpi*; Arunta, Ilyowra, *Qualba*; Warramunga, *Nadama*; Tchingilli, *Kalama*; Mudburra, *Wambanna*.

This also is essentially a North Australian species with an east-west range similar to that of *O. unguifera* but it extends further south, viz., to approx. 24° S. lat. and probably formerly occupied all the area to the north of that parallel. I have no records for sector 5 but as it occurs to north and south of that block, this is probably not significant. In sector 8 the the only records are at the western end and it may have been absent from the Barkly Tableland as so many other species were.

The locality records are: sector 4, many points in and about the western Macdonnells, including the Mareeni Plain; south of Mount Sonder; the Oqualpi Plain near Mount Razorback (a famous haunt in earlier years); west of Mount Heughlin; Haasts Bluff; and further north, west of the Napperby Hills and the Warburton Creek. To the east of Stuart's Line, between the Bundey and Frazer Rivers, Lucy Creek, Huckitta and west of the Tarlton Range; sector 6, Argadargada on the Sandover River, the Elkedra River area and east of the Davenport Range; and in sector 7, Banka Banka.

Though in very small numbers, this beautiful hare wallaby is well known to the natives as a living species over wide areas and today it has a much stronger hold on the country than *L. hirsutus*, and its long persistence in the cattle country of sector 4 augurs well for its future in the Centre. There are recent sight records of it from several of the above localities.

Central Australian material examined comes from the Mareeni Plain and between the Frazer and Bundey Rivers.

The local form conforms in a general way to *L. c. leichardti* Gould.

Lagorchestes hirsutus Gould 1844

Pitjanjarra, *Marla* (*Maala*) (very widely used); Ilyowra, *Adnungwa*; Walpari, *Deelanda*.

The headquarters of this species are in the great spinifex deserts to the west of the area here considered and the Central Australian population may be considered as an overlap from that region. The records involve sectors 2 and 4 at many points, but there are no satisfactory records from 1 and 3 and few from the northern areas in 5, 6, 7 and 8. A former sparse occurrence in 5, 6 and 7 is probable, though aboriginal knowledge of it is much less developed there than in the south-west. It is not known with certainty whether it reached the Queensland border, and its southern limit in South Australian territory was never determined and is now indeterminable.

The locality records are as follows:—Sector 2: south of the Cavenagh Range; south-west of the Barrow Range; Koonapandi and

Pundi, south of the Musgrave Range; between the Everard and Musgrave Ranges; north of Sladden Waters between the Rawlinson Range and the Robert Range; Docker Creek and Mount Jenkins, north and south respectively of the Petermann Range; north of Lake Amadeus; between Mount Conner and Murrachurra. Sector 4: Wytookarri (N.W. of Lake Amadeus); Dare's Plain in the George Gill Range area; near Lake Mackay; McEwin Hill; Mount Doreen; west of Warburton Creek and north of the Sandover River about 40 miles upstream from the Bundey junction. Sector 5: between the Lander and Davenport Ranges. Sector 6: west of Banka.

The species has been encountered on the Canning Stock Route further west, between wells 28 and 43, in the latitudes of sectors 2, 4, 5 and 7 of the present area.

The mode of occurrence of this hare wallaby is fluctuating and discontinuous and with isolated colonies widely sundered—circumstances which always add to the difficulties of estimating status. But there seems no doubt that a major collapse in its numbers in the south-west has occurred in the last 25 years.

In 1956 the testimony of natives who still hunt yearly in the sand tracts south of the Musgrave, Mann and Tomkinson Ranges (where it was one of their chief food supplies in 1932-35), was that it was "finished". It is certainly a comparatively rare animal in any part of Central Australia today, and in the districts where it lives sympatrically with *L. conspicillatus*, is much scarcer than that species.

Material has been examined from most of the localities quoted above, and the marginal specimens are from the Canning Stock Route in the Sand Ridge Desert of Western Australia; Barrow Range; Lake Mackay and Pundi, 50 miles south-west of Koonapandi in the Musgrave Range.

Lagorchestes asomatus Finlayson 1943

Knowledge of this species is still confined to the holotype skull, which came from the Lake Mackay area of sector 4.

Bettongia penicillata Gray 1837

Pitjanjarra, *Karpitchi*; Ilyowra, *Indwarritcha*; Worgaia, *Windijarra*; Warramunga, Walpari, *Yelkamin.*

There are records in sector 2, from Pundi, 50 miles south of the Musgrave Range; Mount Harriett between Pundi and the Range; at

Waldana Spring, 100 miles south of Pundi; Unyaba Hill, between the Everard and Musgrave Range; and near Mount Conner. In sector 4 at Huckitta and in the Lake Mackay area; on the Rankin Creek and east of Davenport Hills in sector 6 and near the Buchanan Creek in sector 8.

This bettong, formerly considered absent from Central Australia, was still extant in very small numbers on both sides of the South Australian Central Australian border in sector 2 in 1932-35, where specimens were obtained by the blacks, and in the Lake Mackay area of sector 4. Elsewhere its presence as an excessively rare or recently extinct species rests on aboriginal testimony. It has now almost certainly been eliminated from sector 2, but may survive as a very attenuated remnant in some of the more northerly localities quoted.

Material examined is limited to two specimens, one from Waldana south of sector 2 and one from the Lake Mackay area of sector 4; the latter has been recognized provisionally on cranial characters alone as a new race, *B. p. anhydra* 1958, but may prove to be a full species when more completely known.

Bettongia lesueuri Quoy and Gaimard 1824

Wonkanooroo, Dieri, *Kanunka*; Pitjaujarra (*s. lato*), *Tchungoo* (very widely used), *Meetika;* Arunta, *Tunnka*; Ilyowra, *Alutta* (very widely used).

A species widely distributed over south-western Australia generally, the area occupied being probably greatest in Western Australia, but covering almost the whole of the State of South Australia and with a south eastern extension in New South Wales and Victoria (1958, *op cit* fig. 1). The central overlap is wide, with a northern limit at about 20° S. lat. It is uncertain whether it enters Queensland territory, but certainly reaches to within 50 miles of it.

The locality records involve sectors 1 to 6 inclusive, but it was rare or absent in most of sector 1 and its heaviest concentrations were in sectors 2 and 4.

This burrowing bettong, unique in the Macropodidae for its fossorial habit, and often proclaiming its presence by the great warrens it excavates, was formerly exceedingly plentiful, and (subject to much local fluctuation) almost universally distributed in sectors 2 and 4, where it was one of the most important of aboriginal accessory food sources. It has now been almost eliminated from the south-western sector and persists only as a rare form in scattered localities in the drainage of the Sandover and Plenty Rivers and in the north-west of sector 6.

The material examined has come entirely from the south-west sector, the chief localities represented being: Chundrinna and Walthajalkanna about 12 and 5 miles north of the Everard Range respectively; several points south of the Musgrave Range in about the same latitude; Allarinna on the north front of the same range; 20 miles east of Mount Conner; 12 miles south-west of King's Creek on the south side of the George Gill Range, and 5 miles north of Desolation Glen in the Rawlinson Range.

Caloprymnus campestris Gould 1843

Dieri, *Wirtiree*; Yowrorka, *Koorjee*; Yalliyanda, Wonkanooroo, *Oolacunta*.

The known distribution of this animal as a recent species is in a portion of the eastern part of the Lake Eyre Basin in sector 1, between Coorabulka in Queensland and Mulka in South Australia and east to Innamincka.

Within this area it occurs in very small numbers but is subject to occasional increase as in 1931. I know of no reliable records since 1935.

Material examined comes from Ooroowillani, Mulka and Cooncheri.

MONODELPHIA

MURIDAE

Except in the case of species of strongly marked characters, the data on individual murids, especially from aboriginal sources is generally less than that for marsupials, and where material also has been scanty, I have not felt justified in speculating on status and distribution, but simply record the localities represented.

Rattus villosissimus Waite 1897

Wonkanooroo, *Miaroo*; Anmatchera, *Artoka*(1); Warramunga, Walpari, *Gootanga* (very widely used); East Arunta, Ilyowra, *Yimala*.

Locality records are from east of Banka, and from Alroy and Alexandria in sector 8; Lake Nash, Wycliffe Well, Elkedra in sector 6;

(1) The same, or a very similar word may be used for a frog which also burrows into creek banks.

Bundey River area, Tarlton Range, Pituri Creek, Napperby Creek in sector 4; Appamunna, Cooncheri, Puttaburra, and Mulka in sector 1.

This is an eastern form with headquarters as a breeding species, in Western Queensland. At intervals of from five to seven years its populations undergo a cyclic increase and it swarms into the adjoining parts of eastern Central Australia occasionally reaching Stuart's Line or slightly beyond. These migratory populations vanish again, usually quite quickly but sometimes persist for as much as 18 months. In the eastern part of the Lake Eyre Basin in sector 1, it is a resident species though normally present in very small numbers, and there is a possibility that the Napperby Creek population south of Stuart's Bluff Range, and perhaps others in the Macdonnells are of the same kind, though it is more likely that they are rather persistent remnants of migration waves.

The material personally examined comes from all four of the sector 1 localities and from all three of those in sector 4, and from unspecified localities in "Central Australia".

Rattus tunneyi Thomas 1904

The subspecies *R. t. dispar* Brazenor 1936 is known from the Alice Springs district in sector 4 and from Tennant Creek on Stuart's Line between sector 7 and 8 and evidently once had a considerable north-south range.

No new material nor data on the status of this species has been obtained during the course of this work.

Material personally examined comes from both the abovenamed places and specimens labelled "Central Australia" have also been seen.

The above two species which are numerically insignificant in "normal" times are apparently the only representatives of the genus in the area.

Pseudomys (Pseudomys) minnie Troughton 1932

Wonkanooroo, *Pallyoora.*

Recorded from Appamunna, Cooncheri, Mulka, Ooroowillani, Innamincka, Cordillo and other points in the eastern portion of the Lake Eyre Basin in sector 1; at Stuart Creek just south of this sector and at Arckaringa in sector 3.

Known to settlers as the River Rat, from its occasional prevalence along the course of the Diamantina and Barcoo channels, it is normally in small numbers but subject to local increase which, however, does not seem to carry it into the more northerly or westerly sectors. A south-easterly form not characteristic of the Centre as a whole.

Material examined from all the above localities and from Ooldea, south of sector 3.

Pseudomys (?Pseudomys) fieldi Waite 1896

This very obscure species is, I believe, still known only by the original specimen obtained by the Horn Expedition at or near Alice Springs in sector 4. It has been variously ascribed by different authors to *Laggadina*, and *Thetomys* as well as *Pseudomys* ss.

Pseudomys (Thetomys) nanus Gould 1858

Pitjanjarra, *Entroota.*

The locality records are Koonapandi and Mount Crombie, south of the Musgrave Range in sector 2; near Alice Springs in sector 4; Barrow Creek and Wycliffe Creek on Stuart's Line between sectors 5 and 6.

Material from all these localities has been examined as well as some labelled "Central Australia" only.

This rat has been variously relegated to "*Mastacomys* sp.", to "*Mus*" *nanus* Gould, and to *Gyomys desertor* Troughton. I have redescribed it fully (1941) and shown that inclusion in *Gyomys* is contra indicated by its cranial characters. Tate (1951) after re-examining the type of *Mus nanus* Gould, dissents from the above identification, but I adhere to it until the matter can be tested by direct comparison. Tate finds the interval of 1,000 miles separating the type locality of *Mus nanus* Gould from that of the above material, good reason for not merging them. It must be recalled, therefore, that a greater distance separates the type locality of *Gyomys desertor* at Wycliffe Creek from that of Victorian specimens taken on the Murray.

Pseudomys (Leggadina) forresti Thomas 1906

The type locality is at Alexandria in sector 8, and a single specimen from Mulka in sector 1 has also been referred to it. Nothing is known as to its status except that it is certainly not plentiful.

Pseudomys (Leggadina) hermannsburgensis Waite 1896

Pitjanjarra, *Menki.*

Locality records are, in sector 2; Wollara, near the Basedow Range; Ayer's Rock; Alpera at the north-west spur of the Musgrave Ranges; Erliwunyawunya, Owellinna, and Ernabella on the south side of the same; Chundrinna on the north side and Karmeena on the south side of the Everard Range: sector 3; Charlotte Waters: sector 4; Hermannsburg; "Macdonnell Ranges"; and Teatree Well: sector 5; Barrow Creek and the Granites: sector 7 8; Tennant Creek on Stuart's Line; and in sector 8 at Alexandria.

Although formerly having a wide distribution outside the central areas and said to have occurred as late as 1857 at the junction of the Murray and Darling Rivers in Victoria, in western New South Wales, south-western Queensland, western and south-western South Australia and south-eastern West Australia, this species is today a characteristically Central Australian form, and provides a curious inversion of the usual regional status of such widely spread mammals. In central latitudes its chief concentration is in the south-west and though it has been recorded from Alexandria in the opposite sector, I could find little aboriginal knowledge of it in many of the intermediate districts in 1950-56.

In 1932-35 it was probably the most plentiful and wide spread mammal in sectors 3 and 2 and in the western half of sector 4, where it still persists, but I could get no evidence of its presence in sector 1 and if it exists today east of Stuart's Line, it is rare.

Material examined has come from all the above localities except the last four.

Pseudomys (Leggadina) waitei Troughton 1932

Pitjanjarra, *Anoola.*

Locality records exist for Mulka in sector 1; Wollara near the Basedow Range in sector 2; "Macdonnell Ranges", Frazer River, and Hart Range, in sector 4.

Little is known about the distribution and status of this species. Most of the above records are based on material taken prior to 1940. A small non saltatory murid which may be this form is still known to natives in the eastern sectors, but no specimens are available in support. The names *Idjibudoo, Witchiburrt* of the Warramunga; *Eeyimma* of the eastern Arunta, and *Umbwinyilpa* of the Ilyowra may be relevant here.

In 1932 it was considered a rare form at Wollara, where it was outnumbered ten to one by *P.* (*L.*) *hermannsburgensis* and was not known in the Musgrave Range districts.

The material personally examined comes from Wollara, "Macdonnell Range" and Frazer River.

Laomys pedunculatus Waite 1896

The original localities from which the Horn Expedition material came were Alice Springs (*s. lato?*) and Illamurta in the James Range. I have acceptable records of it since at Hugh Creek in the Macdonnell Ranges; from the Napperby Hills south of Stuart's Bluff Range, also in sector 4; and in the Davenport Range in sector 6.

This species seems now to be rare and no material of it could be obtained during the field work of 1931-35. It is still extant, however, and the three additional records provided are based on specimens taken, though not examined by me—the Hugh Creek in 1935; Napperby Hills in 1950 and Davenport Range in 1953. The latter represents a considerable extension of range—200m. north of Alice Springs.

Material examined is from Alice Springs (*?s. lato*) and from Illamurta, and includes the dubious variety "*brachyotis*".

There are as yet, I believe, no records of the related species *Laomys woodwardi* Thomas (based on Wyndham in the Kimberley Division of Western Australia) within the area here considered, nor of *Zyzomys argurus* Thomas, though the latter has been taken by Tate (1951, p. 265) in the Mount Isa district of western Queensland, about 100 miles from the Central Australian border in sector 6. There are native accounts of a large brush-tailed rat living a subarboreal life on the lightly timbered plains in the north-west of sector 4 and adjoining portions of sector 5. The Anmatchera of these parts speak of it as of something belonging to a recent past, and their accounts suggest a *Conilurus* sp. cf. *hemileucurus*.

Leporillus apicalis Gould 1853

Pitjanjarra, *Tchujalpi*; Arunta, *Turulpa*; Pintubi, *Tweealpi*.

Locality records are from the country south of the hills between Ayers Range and the Cavenagh on the 26th parallel; and west of Mount Crombie, in sector 2; and west of Mount Peculiar and at "Alice Springs" in sector 4.

This species, which is believed to have had a wide range over south-eastern Australia, was first noted in Central Australia by Ernest Giles in 1872. It seems always to have had a rather frail hold there and by 1940 had become a rare form even in the virgin districts of the Aboriginal Reserves, and was quite unknown in the pastoral country of the mid Macdonnells where the Horn Expedition obtained it. If it survives today it is probably in the north-west of sector 4, and must be in very small numbers.

Two specimens have been examined, obtained near Mount Crombie in 1933, by Messrs. Hackett and Tindale, and one of the Horn Expedition, from "Alice Springs".

Leporillus conditor Gould 1849

Wonkanooroo, *Wopilkara.*

Although definite locality records are lacking, this species was accorded by general repute, a wide distribution at the beginning of pastoral occupation, in the southern part of sector 1, exclusive of the Arunta desert, and as far west as the Arckaringa tablelands in sector 3. An interval of nearly 400 miles separates the most northerly specimens of *conditor* examined, from the most southerly of the central population of *apicalis.* But this may not be significant and whether the two species ever overlapped in these latitudes as they seem to have done further to the south-east, is now a matter of speculation.

By 1931 it had become very rare in the Lake Eyre districts, and it is doubtful if it still survives there, though it does so far to the south-west near the southern margin of the Nullarbor Plain.

Material examined was taken in 1907 near the western shore of Lake Eyre North, near the boundary of sectors 1 and 3.

Notomys alexis Thomas 1922

Yankunjarra, *Darganarra*; Pitjanjarra, *Wilchimba.* Other names in use for *Notomys* spp. close to *alexis* but not specifically identified are: Pitjanjarra, *Ilpalya*; Kukatja, *Aupa, Illyakirri*; East Arunta, Ilyowra, *Allabaiya, Kurunja*; Tchingilli, *Munyininni.*

The species of *Notomys* appear, vanish and reappear at such unexpected places and times that it would be highly unsafe to dogmatize as to the local status or distributional headquarters of any of them. The recorded limits of *alexis*, however, exceed those of all other inland species and there can be little doubt that it is the dominant form today over the whole of Central Australia, with the exception of the districts about Lake Eyre in the south-east. The locality records involve all 8 sectors, and are numerous, especially in the south-west.

In 1932-35 it was exceedingly plentiful in sectors 2 and 3 and in one or two restricted localities such as Wollara in the Basedow Range area and Chundrinna and Walthajalkanna near the Everard Range, it constituted a minor plague. It is still present in these sectors, but it is many years since it has been seen in large numbers. Elsewhere it persists but has not been reported in large numbers in any of the areas personally visited.

Long series have been examined, the peripheral localities being: Warburton Range and Canning Stock Route in the west; Alexandria and Alroy in the north; Haddon Downs in the south-east and Oolarinna below the Everard Range in the south.

Notomys amplus Brazenor 1936

Knowledge of this large species still depends upon Brazenor's original description of two females from Charlotte Waters in sector 3, taken by the Horn Expedition in 1896.

The Pitjanjarra of the Musgrave Range have a name *Arruja,* for a species of *Notomys* much larger than the *Dargawarra,* but it seems to be almost legendary at the present day.

Notomys cervinus Gould 1853

Wonkanooroo, *Oorarrie.*

In the past this species has been much confused with *N. alexis* and *N. fuscus eyreius,* which has tended to give it a fictitiously wide range. Following a re-examination of the type by Morrison-Scott and Tate (1951 *op. cit.*, p. 262) the writer (1960) gave a summary redescription of the species and the locality records now quoted conform to this conception of its characters.

The main distribution belt appears to be to the east and south and only sectors 1 and 3 are involved in the records. These are: Roseberth, 25m. north of Birdsville; Birdsville; Appamunna; Pandi Pandi; Cooncheri; Cowarie; and Mulka, all in the southern part of sector 1 on both the Queensland and South Australian sides of the border and Charlotte Waters in sector 3.

Normally its occurrence is very sparse but it is subject to periodic increase in the Lake Eyre Basin as in 1930-31.

Material has been examined from all the above localities except the first.

Notomys fuscus Wood Jones 1925

Wonkanooroo, *Wilkintie.*

The type locality of this species is at Ooldea, south of the area here considered, but a local form of it distinguished by the trinomial *eyreius* (1960 *op. cit.*) occurs sympatrically with *N. cervinus* in sectors 1 and 2. The localities are: Putta Burra; Etadinna; Mulka; Cordillo and Innamincka in sector 1; and at Charlotte Waters in sector 3.

This species has been plentiful in the Lake Eyre Basin recently (1957) but is normally in small numbers.

Material personally identified is from all the above localities.

The specimen assigned under this name to the Basedow Range by Tate (1951, *op. cit.*, p. 263) is an intermediate of *N. alexis alexis* and *N. alexis everardensis.*

Notomys longicaudatus Gould 1844

Arunta, *Ulubaiya* (of Spencer).

Locality records are: Mount Burrell, and the Burt Plain north of Alice Springs, in sector 4; Barrow Creek in sector 5.

This large species was first obtained in Central Australia by the Horn Expedition of 1896, and again taken by Spencer at Barrow Creek in 1901. I have been able to obtain no more recent material and reports of larger species than *N. alexis* though current, are vague as to survival. The word Allabaiya, listed above for indeterminate species of *Notomys,* is obviously the same as Spencer's quoted here. It was heard on the Sandover and at Pituri Creek on the Queensland border of sector 4 but was not applied to a particularly large species.

One specimen examined (date unknown) from Mount Burrell.

Notomys mitchelli Ogilby 1839

Localities from which this species has been recorded are Dickaree, 40m. north of Birdsville, and Birdsville in sector 1; "Alice Springs" in sector 4; and "Central Australia".

The occurrence in the Lake Eyre Basin was recorded by Tate (1951) and has recently been confirmed (1959) but the others are based on old specimens of somewhat doubtful history.

N. mitchelli appears to be numerically of minor importance as a Central Australian species, but its general status there is obscure.

Material personally examined comes from the Lake Eyre Basin in sector 1 and from "Alice Springs" and "Central Australia".

Hydromys chrysogaster Geoffroy 1804

Wonkanooroo, *Tinna appa.*

Locality records are from the Barcoo and Diamantina Rivers and outlying lagoons of sector 1, south-east of the Arunta Desert.

The water rat is not in large numbers in this district but is persistent and has adapted itself successfully to the violent fluctuations of its domain, which may change almost overnight from a small pool isolated by hot wastes of sand drifts and stony deserts, to an inland sea. In view of its known hardihood and resource it is somewhat remarkable that it has never colonised the Finke valley where some of the western tributaries provide permanent water; but persistent enquiry there has revealed no trace of it as a living species, nor aboriginal knowledge.

It may be present in the streams of the north-west of sector 7 and north-east of sector 8, but much of their drainage is in Torresian lands.

Material examined is from the Barcoo River near Innamincka, and conforms in a general way to *H. c. fulvolavatus* Gould 1853.

Canis familiaris dingo Blumenbach 1780

Dieri, *Kinturra*; Wonkanooroo, *Mudla*; Pitjanjarra (*s. lato*), *Tchitoodja, Papa* (*Papa inurra*); Arunta, *Adnerra*; Ilyowra, *Ag yun ga*(1); Walpari, *Malik*; Warramunga, *Kunaba*; Tchingilli, *Iminji*; Mudburra, *Winjiwannoo.*

The dingo is ubiquitous in Central Australia and the present day security of its status is one of the major grievances of the pastoral community. Although steadily persecuted by poison bait, trap and native hunter, it succeeds in maintaining itself—often in surprising numbers—wherever watering facilities and suitable breeding grounds are to be found.

Material examined comes from many localities chiefly in sectors 2 and 4.

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(1) This word has been distorted in spelling, in an attempt to contrast it with the Ilyowra word for the euro—*Arrunga*—from which, in rapid speech, it is almost indistinguishable by Europeans.

CHIROPTERA

Comparatively little is known about the bat fauna of Central Australia. It has sometimes been assumed that aridity and a quantative reduction of insect life as a whole, are concommitants which must necessarily lead to a parallel poverty of microchiroptera, both in species and individuals. How true this may be, can only be tested by systematic collecting. A study of the known distribution of Australian bats, indicates that in a considerable number of cases where the species has not yet been taken in Central Australia, the records straddle that area, either from north to south or more often from east to west, and it seems likely that more field work will show that some of them are actually exploiting the region, as a seasonal activity, at least.

The writer did not collect systematically in this group and such results as were obtained were more or less incidental to other work. On several occasions native children brought in quite large series of the smaller kinds, which in general they seemed to have no difficulty in locating. The species represented by this material and the localities involved are listed below together with previously published records—some of the latter are of long standing and may need review and the identifications should be regarded as provisional.

The following names are used for bats in general:—Wonkanooroo, *Pinchipinchinarra*; Pitjanjarra, *Pindinarra, Oolpoolparrie*; Ilyowra, Arunta, Walpari, *Anjibeera*; Tchingilli, Mudburra, *Nullaminminni.*

Pteropus cf. scapulatus Peters 1862

Warramunga (?and Kaitish), *Petong, Bitango, Wilwanunga*; Worgaia, *Wundoogarri*; Tchingilli, *Piljeena*; Mudburra, *Wolpaooroo*; Mara, Alowa, *Matchoo*; Yanula, *Murrainjinya*; Larrakia, *Lumuleena.*

Locality records: Arthur Creek, Pituri Creek and Sandover River in sector 4; Frew River in sector 6; Bank Banka in sector 7; Buchanan and Playford Creeks in sector 8.

After a descent by easy stages from the green, well watered country of the northern tribes who use the above names, into the much less well favoured territory of the Warramunga, it was surprising to find the latter well acquainted with this fruit bat as a frequent visitor. The furnace like gorges and spinifex clad quartzite screes of the Murchison-Davenport Range area seem very incongruous habitats for such a creature, but it appears that after rains it exploits for a season the wealth of eucalypt blossom which follows along the creeks and is relished as a food item by the blacks.

*N

The visitations are regular in sector 8, frequent in sectors 7 and 6 and occasional in sector 4. In the latter they are often reported drowned in open tanks.

No material has been examined and it is possible that 2 *Pteropus* spp. are involved—but specimens of *P. scapulatus* were immediately recognized as the more frequent.

Macroderma gigas Dobson 1880

Arunta, *Elkintera* (Spencer and Gillen).

Locality records are: "Alice Springs", Mount Conway, Frazer River, Ellery Creek Gorge, Field River at ca. 23° 30′ S. lat. in sector 4, and "Central Australia".

Although its general status is that of a relict species, the Ghost Bat is less rare than formerly thought and is quite widely spread in Central Australia and adjoining tracts. The recession has been from the south. Old men of the Pitjanjarra knew it 40 years ago in the Musgrave, Mann and Tomkinson Ranges, whence it has now long gone.

Material has been examined from most of the above localities.

Nyctophilus geoffroyi Leach 1822

Pandi Pandi, Putta Burra on the Diamantina River and "Lake Eyre" in sector 1 (material); Tempe Downs on the Palmer Creek (mat.) and Horne Expedition, in sector 4; Tennant Creek (mat.) sector 7; Alexandria in sector 8.

N. g. pallescens Thomas 1913 is based on Alexandria.

Eptesicus pumilus Gray 1841

Officer Creek (mat.) sector 2; Temple Bar (mat.) and Brook's Soak (mat.) in sector 4.

E. p. caurinus Thomas 1914 has been recorded from Mount Isa ca. 100 miles east of the Central Australian border.

Chalinolobus gouldi Gray 1841

Barcoo River (mat.) sector 1; Erliwunyawunya (mat.) and Ernabella (mat.) in the Musgrave Range of sector 2; Tempe Downs on Palmer Creek (mat.) in sector 4; Tennant Creek (mat.) in sector 7; Alexandria, sector 8.

C. g. venatoris Thomas 1908 has Alexandria as its type locality.

Chalinolobus cf. morio Gray 1841

"Lake Eyre district" (mat.) in sector 1; Officer Creek (mat.), Ernabella (mat.) and Wollara (mat.) north of Basedow Range in sector 2.

Scoteinus greyi Gould 1858

Lower Barcoo River (mat.) in sector 1; Tennant Creek (mat.) and Sturt Creek in sector 7; Alexandria in sector 8.

Scoteinus balstoni Thomas 1906

This has been identified in collections from the Canning Stock Route in the Great Sandridge Desert, Wells 43-46, by Glauert (? unpublished record). The localities are in the latitudes of sectors 5 and 6.

Taphozous australis Gould 1854

Tennant Creek (mat.) in sector 7.

This bat has previously been recorded from Cloncurry, ca. 150 miles east of the Northern Territory border.

Taphozous flaviventris Peters 1867

Junction of Warburton and Tower Creeks (mat.) in sector 4.

This species is stated by natives to frequently appear in the above area for a short time in late summer.

Nyctinomys australis Gray 1839

Birdsville in sector 1; "Central Australia" (mat.) = sector 4.

The Birdsville record (Tate 1952, *op. cit.*) is attributed to *N. a. atratus* Thomas 1924 the type of which is from Ooldea, south of sector 2 (Wood Jones 1925).

Chaerephon plicatus Buchanan-Hamilton 1800

Alexandria in sector 8.

This yielded the type of *C. p. colonicus* Thomas 1906. The species has been recorded from Cloncurry, 150m. east of the Northern Territory border and I have examined material also from Boulia, just east of sector 1.

SOME INTRODUCED MAMMALS

Feral populations of horses, donkeys, goats and camels are of local occurrence and though not without influence on the native fauna, call for no special treatment here. It may be noted in passing that the feral water buffalo of the north coast (*Bos bubalis* auct.) drifts sporadically over the northern borders of the area here considered and has been observed at the following localities: Sturt Creek in sector 7 (1925); 40m. east of Alexandria H.S. in sector 8 (1953) and between Tanami and the Granites, sector 5 (1927).

In a different category from these ungulates however, are the house mouse, rabbit, fox and cat which owe their introduction much more remotely to human influence and which are, or may become in future, all pervading. The distribution and status of these pests will no doubt be the subject of properly organized surveys—in the meantime I take the opportunity of recording a few facts which have been ascertained incidentally during this work.

Mus musculus Linne 1758

Wonkanooroo, *Punta punta*; Ilyowra, *Undeluquil*.

So far as personal observation goes I have records of this animal as a bush living species only in the southern sectors 1, 2, 3 and 4. That populations of it exist in the vicinity of European settlements in the other sectors is certain, and that it will ultimately be universally distributed, is very probable.

I have already (1939) discussed it at length in the Lake Eyre Basin of sector 1, and have drawn attention to the fact that its populations there are of long standing, considerably differentiated from urban types, and may actually represent a derivation from Asia, long predating European occupation of this country. In this sector it is subject to periodic increase to plague proportions, but elsewhere seems to be as yet, a very minor influence in the faunal economy. In 1932-35 it was in considerable numbers in various parts of sector 2—as at Wollara for example, where W. H. Liddle's settlement at Angas Downs had given it a start—but it was largely masked by the very large populations of *Ps.* (*Leggadina*) *hermannsburgensis* and *Notomys alexis*. In the intervening years there have been some sharp local increases in its numbers, but its status as a whole does not seem to have changed much.

Rattus norvegicus Erxleben and *R. rattus* Linne, vars., which latter has free living rural populations in many parts of Australia, do not seem to be able to colonize the Centre. The environment is apparently definitely adverse to the genus, and the two indigenous species which have been recorded have only a very slight hold outside the Lake Eyre Basin.

Oryctolagus cuniculus Linne 1758

"*Rabbita*" very generally used by natives.

Locality records cover all sectors, but as a pest it is chiefly of importance in 1, 2 and 3, and north of sector 4 (ca. 22° S. lat.) its numbers are never great. The following progressively northern records were obtained during the work of 1950-56. Kurundi, Lake Nash, between Phillip Creek and Bank Banka, Alexandria, Herbert Vale, near Camooweal, Helen Springs, 15 miles south of Newcastle Waters, and Newcastle Waters. At Daly Waters, Katherine and Darwin there are older sight records, thought to be due to escape of individuals held for experimental purposes, but Ratcliffe and Calaby (1958) record a thriving colony at Normanton on the Gulf of Carpentaria. Some of the reports of large warrens in the north-west of sector 5 are probably due to confusion with *Bettongia lesueuri*.

The arrival of the rabbit in the Centre was via the Lake Eyre Basin in sector 1 in 1889 or 1890. In 1901 Maurice and Murray recorded it as already plentiful in the Musgrave Range area and in 1902, en route to the Cambridge Gulf, they found it as far north as Lake Amadeus. Murray as early as 1905 saw its tracks at Kurundi, in the Davenport Range of sector 6, which is near the present northern limit of uniform occupation.

The enormous reproductive potential of the species is chiefly responsible for its being almost chronically out of equilibrium with its Central Australian environment and its history in most districts is one of plague numbers being built up after unusually good rains, followed by large scale mortality, and then a period—often of several years—of scarcity or near extinction. So far as the local numerical change is concerned, this is more or less characteristic of many mammals of the area, but in the case of the rabbit the amplitude of its population flux is far greater than in any of the native species and it does not appear capable of dispersing protectively as they do.

It should be noted however that good eye witnesses have stated that at times of large scale mortality a proportion of the rabbits have shown symptoms outwardly quite similar to those of modern myxomatosis. Some of these observations predate the deliberate introduction of that virus by 40 years or more.

Vulpes vulpes Linne 1758

Pitjanjarra, *Torka* (said to be an attempt to reproduce the English sound "fox" which is very difficult for them).

Locality records involve sectors 1 to 6 but north of sector 4 it is still something of a curiosity. The most northerly report obtained (1956) was between Elkedra and Hatches Creek in sector 6, but there are much more northerly observations to east and west of the Centre, viz.: at Inverleigh, 45m. south-west of Normanton on the Gulf of Carpentaria in Queensland and at Wyndham in the Kimberley Division of Western Australia at ca. 15° 32′ S. lat.

Foxes were noted at Anna Creek in sector 3 in 1910 and for two decades subsequently made only slow progress in their northern advance. In the field work of 1932 they were found to be well known to natives and white doggers in the Everard and Musgrave Ranges of sector 2, though still in quite small numbers. They reached the Basedow Range in 1933 and Harper Springs in 1937; the latter is just east of Stuart's Line and near the northern border of sector 4 which is now completely occupied from east to west.

At the present time the densest fox population is centred in sectors 2 and 3 and it is in the virgin, pastorally unoccupied areas of the former that the most spectacular damage to the native fauna has accrued. The bounty on fox scalps which was paid in South Australia in earlier years has unfortunately long been discontinued so that it is not possible to get numerical estimates of its status, as with the dingo. But at Ernabella in the Musgrave Range, where large numbers of dingo scalps are traded in every year, native hunters interrogated in 1956, stated that in the area immediately to the south of the Musgrave, Mann, and Tomkinson Ranges (which yields most of their dog scalps), the fox now outnumbers the dingo. The annual take of dingo scalps in this area for the eight years prior to 1956 is stated to have fluctuated from 500 to 3,000, with an average of ca. 1,300, and the maximum in 1956.

Felis cattus domesticus Linne 1758

Pitjanjarra (*s. lato*), *Ngaiya* (= meeow), *Mulcoo*.

Although no systematic work has been done on the distribution of the feral cat, it is probable that at the present time it is ubiquitous in Central Australia. Wells' record of one seen during the Elder Expedition in 1891, 100 miles south-west of Mount Squires in the northern portion of the Victoria Desert and 400 miles from any

European settlement, is remarkable evidence of the extent of its penetration and the duration of its tenure.

In sector 1 it sometimes increases markedly during rodent plagues, but elsewhere its numbers are moderate, and as the natives hold it in high esteem gastronomically, it may possibly be checked somewhat, wherever there are active hunting populations.

SUMMARY

The results of two periods of field work on Central Australian mammals in 1931-35 and 1950-56, are combined with existing data in a summary statement on the distribution of the known species.

The area dealt with is subdivided into 8 sectors which are indicated on a map and briefly defined.

Factors having a potent influence on the status of mammals in Central Australia, are briefly discussed.

Some native names, obtained during the field work, are recorded.

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APPENDIX 1

Alphabetical list of aboriginal names used in the text.

Name	People	Species
Achilpa	Arunta: Ilyowra	*Dasyurus geoffroyi*
Adnerra	Arunta	*Canis familiaris dingo*
Adnungwa	Ilyowra	*Lagorchestes hirsutus*
Alarra	Ilyowra: ? Worgaia	*Macropus rufus*
Allabaiya	Arunta: Ilyowra	*Notomys* sp.
Alluta	Ilyowra	*Bettongia lesueuri*
Ampurta	Arunta: Ilyowra	*Dasycercus cristicauda*
Andunya	Arunta	*Trichosurus vulpecula*
Anoola	Pitjanjarra	*Ps. (Leggadina) waitei*
Anpa	Kukatja	*Notomys* sp.
Anjibeera	Ilyowra: Arunta: Walpari	Bats (in general)
Anuljalu	Ilyowra	cf. *Sminthopsis* sp.
Areenin	Ilyowra: ? Worgaia	*Macropus robustus*
Arrajanuta	Arunta: Ilyowra	*Antechinomys spenceri*
Arrawa	Arunta: Ilyowra	*Petrogale lateralis*
Arruja	Pitjanjarra	*Notomys* sp. (large)
Arrunga	Arunta: Ilyowra	*Macropus robustus*
Artoka	Anmatchera	*Rattus villosissimus*
Ayoorta	Arunta: Ilyowra	*Thalacomys lagotis*
Ay yunga	Ilyowra	*Canis familiaris dingo*
Bitango	Warramunga: ? Kaitish	*Pteropus* sp. cf. *scapulatus*
Bukquroo	Warramunga: Mudburra	*Isoodon* or *Perameles* sp.
Bunyilba	Ilyowra	cf. *Sminthopsis* sp.
Butgoola	Tchingilli	*Isoodon* or *Perameles* sp.
Dargawarra	Pitjanjarra	*Notomys alexis*
Deelanda	Walpari	*Lagorchestes hirsutus*
Djalku	Pitjanjarra	*Thalacomys lagotis*
Eecharricharri	Pitjanjarra	*Notoryctes typhlops*
Eeyimma	Arunta	cf. *Leggadina* sp.
Elkintera	Arunta	*Macroderma gigas*
Entroota	Pitjanjarra	*Ps. (Thetomys) nanus*
Gootanga	Warramunga: Walpari	*Rattus villosissimus*
Gowngar	Wombaia	*Trichosurus vulpecula*
Idjibudoo	Warramunga	cf. *Leggadina* sp.
Illyakirri	Kukatja	*Notomys* sp.
Ilpalya	Pitjanjarra	*Notomys* sp.
Iminji	Tchingilli	*Canis familiaris dingo*
Inappa	Wonkanooroo	*Tachyglossus aculeatus*
Inarlinga	Arunta	*Tachyglossus aculeatus*
Indwarritja	Ilyowra	*Bettongia penicillata*
Inniwallinga	Wonkanooroo	*Tachyglossus aculeatus*
Itjaritjara	Pitjanjarra	*Notoryctes typhlops*
Jobodo	Tchingilli	*Dasyurus* sp.
Joodama	Mudburra	*Macropus robustus*
Jungunar	Mudburra	*Trichosurus vulpecula*

APPENDIX 1—*continued*

Name	People	Species
Kalama	Tchingilli	*Lagorchestes conspicillatus*
Kanunka	Wonkanooroo : Dieri	*Bettongia lesueuri*
Kapita	Dieri	*Thalacomys lagotis*
Karpitchi	Pitjanjarra	*Bettongia penicillata*
Keelyilli	Tchingilli	*Tachyglossus aculeatus*
Keenika	Yankunjarra	*Dasyurus geoffroyi*
Kinturra	Dieri	*Canis familiaris dingo*
Kirimbu	Mara	*Macropus robustus*
Koongarra	Wonkanooroo	*Macropus rufus*
Koorjee	Yowrorka	*Caloprymnus campestris*
Kowari	Wonkanooroo	*Dasyuroides byrnei*
Kudjani	Mara	*Trichosurus vulpecula*
Kulara	s. Ilyowra	*Petrogale lateralis*
Kulwarri	Tchingilli	*Isoodon* or *Perameles* sp.
Kunaba	Warramunga	*Canis familiaris dingo*
Kunala	Pitjanjarra	*Macropus robustus*
Kunjilba	Pitjanjarra	*Choeropus ecaudatus*
Kunnakulumbi	Walpari	cf. *Sminthopsis* sp.
Kunula	Pitjanjarra	*Macropus robustus*
Kurunja	Ilyowra : Arunta	*Notomys* sp.
Luali	Larrakia	*Dasyurus hallucatus*
Lumuleena	Larrakia	*Pteropus* cf. *scapulatus*
Maala	Pitjanjarra	*Lagorchestes hirsutus*
Makoora	? Nadadjera	*Isoodon* or *Perameles* sp.
Malik	Walpari	*Canis familiaris dingo*
Maloweea	Mara	cf. *Sminthopsis* sp.
Marloo	Pitjanjarra	*Macropus rufus*
Maradjee	Warramunga	*Macropus robustus*
Marrabun	Warramunga	*Trichosurus vulpecula*
Matchoo	Mara : Alowa	*Pteropus* cf. *scapulatus*
Meetika	Pitjanjarra	*Bettongia lesueuri*
Melatjhani	Wonkanooroo	*Sminthopsis larapinta*
Menki	Pitjanjarra	*Ps. (Leggadina) hermannsburgensis*
Miaroo	Wonkanooroo	*Rattus villosissimus*
Mudagoora	Wonkanooroo	*Dasycercus cristicauda*
Mudla	Wonkanooroo	*Canis familiaris dingo*
Mulooo	Pitjanjarra	*Felis cattus domesticus*
Mundawuljiwulji	Walpari	*Notoryctes typhlops*
Mungawyuroo	Pitjanjarra	*Trichosurus vulpecula*
Munyininni	Tchingilli	*Notomys* sp.
Munyoolba	Arunta	cf. *Sminthopsis* sp.
Muritja	Pitjanjarra	*Dasycercus cristicauda*
Murrainjinya	Yanula	*Pteropus* cf. *scapulatus*
Myarin	Mudburra	*Isoodon* or *Perameles* sp.
Nadama	Warramunga	*Lagorchestes conspicillatus*
Narloodi	Walpari	*Dasycercus cristicauda*
Nilee	Wonkanooroo	*Sminthopsis crassicaudata*
Nilliyilloo	Worgaia	*Tachyglossus aculeatus*
Ngaiya	Pitjanjarra	*Felis cattus domesticus*
Nginana	Pitjanjarra	*Perameles eremiana*
Ngingulda	Tchingilli	*Tachyglossus aculeatus*
Ngynoo	Pitjanjarra	*Thalacomys lagotis*
Nullaminminni	Tchingilli : Mudburra	Bats (in general)

APPENDIX 1—*continued*

Name	People	Species
Nyurloo	Pitjanjarra	*Isoodon auratus*
Okirra	Arunta	*Macropus rufus*
Oolacunta	Yalliyanda : Wonkanooroo	*Caloprymnus campestris*
Oolbulla	Alowa	*Tachyglossus aculeatus*
Oolpoolparri	Pitjanjarra	Bats (in general)
Oorarri	Wonkanooroo	*Notomys cervinus*
Oqualpi	Kukatja	*Lagorchestes conspicillatus*
O urra	Ilyowra	*Macropus rufus*
Pallyoora	Wonkanooroo	*Pseudomys minnie*
Papa	Pitjanjarra	*Canis familiaris dingo*
Partjada	Pitjanjarra	*Dasyurus geoffroyi*
Petong	Warramunga : ? Kaitish	*Pteropus* cf. *scapulatus*
Piljeena	Tchingilli	*Pteropus* cf. *scapulatus*
Pinchi pinchi narra	Wonkanooroo	Bats (in general)
Pindinarra	Pitjanjarra	Bats (in general)
Pitchi pitchi	Yankunjarra	*Antechinomys spenceri*
Poodoojooroo	Kukatja	*Perameles* or *Isoodon* sp.
Pulchida	Pitjanjarra	*Dasyurus geoffroyi*
Punta punta	Wonkanooroo	*Mus musculus*
Qualba	Arunta : Ilyowra	*Lagorchestes conspicillatus*
Rance	n. Ilyowra : ? Worgaia	*Petrogale lateralis*
Taich	Ilyowra	*Isoodon* or *Perameles* sp.
Tajadi	Kukatja	*Dasyurus geoffroyi*
Tajinna	Walpari	*Dasycercus cristicauda*
Takooladji	Tchingilli	*Trichosurus vulpecula*
Talgoo	Pitjanjarra	*Thalacomys lagotis*
Tchilkamutta	Pitjanjarra	*Tachyglossus aculeatus*
Tchirilya	Pitjanjarra	*Tachyglossus aculeatus*
Tchitoodja	Pitjanjarra	*Canis familiaris dingo*
Tchujalpi	Pitjanjarra	*Leporillus apicalis*
Tchukooroo	Dieri	*Macropus rufus*
Tchungba	Walpari	*Trichosurus vulpecula*
Tchungoo	Pitjanjarra	*Bettongia lesueuri*
Tchungunba	Walpari	cf. *Sminthopsis* sp.
Tchunma	Mudburra : Tchingilli : Warramunga	*Onychogale unguifera*
Thulka	Wonkanooroo	*Thalacomys lagotis*
Tinna appa	Wonkanooroo	*Hydromys chrysogaster*
Tnunka	Arunta	*Bettongia lesueuri*
Torka	Pitjanjarra	*Vulpes vulpes*
Towala	Pitjanjarra	*Onychogale lunata*
Turulpa	Arunta	*Leporillus apicalis*
Twoealpi	Pintubi	*Leporillus apicalis*
Unbwinyilpa	Ilyowra	cf. *Leggadina* sp.
Undeluquil	Ilyowra	*Mus musculus*
Undinna	Ilyowra	*Trichosurus vulpecula*
Wagunyamenzi	Tchingilli	*Onychogale unguifera*
Wailburdi	Yankunjarra	*Myrmecobius fasciatus*
Wajingurri	Warramunga	*Tachyglossus aculeatus*
Wakunja	Mudburra : Tchingilli : Warramunga	*Onychogale unguifera*

APPENDIX 1—*continued*

Name	People	Species
Walbunba	Yankunjarra	cf. *Sminthopsis* sp.
Walpaooroo	Mudburra	*Pteropus* cf. *scapulatus*
Wambanna	Mudburra	*Lagorchestes conspicillatus*
Wamburra	Worgaia	*Trichosurus vulpecula*
Wangurra	Mudburra	*Macropus rufus*
Wannumbeera	Alowa	*Dasyurus hallucatus*
Warrigiddi	Warramunga : Wombaia	*Thalacomys lagotis*
Warroo	Pitjanjarra	*Petrogale lateralis*
Watabunmurra	Tchingilli	*Macropus robustus*
Wilchimba	Pitjanjarra	*Notomys alexis*
Wilkinti	Wonkanooroo	*Notomys fuscus eyreius*
Willwanunga	Warramunga : ? Kaitish	*Pteropus* cf. *scapulatus*
Windijarra	Worgaia	*Bettongia penicillata*
Winjiwanoo	Mudburra	*Canis familiaris dingo*
Wintarro	Pitjanjarra	*Isoodon auratus*
Winnijungoo	Warramunga	*Dasyurus* sp.
Wirtiree	Dieri	*Caloprymnus campestris*
Witchiburrt	Warramunga	cf. *Leggadina* sp.
Woonyaboonya	Mara	*Dasyurus hallucatus*
Wopilkara	Wonkanooroo	*Leporillus conditor*
Wulpoorti	Yankunjarra	*Myrmecobius fasciatus*
Wundoogarri	Worgaia	*Pteropus* cf. *scapulatus*
Wyoota	Pitjanjarra	*Trichosurus vulpecula*
Yalbo urru	Tchingilli	*Thalacomys lagotis*
Yallara	Wonkanooroo	*Thalacomys minor*
Yarninga	Walpari	*Thalacomys lagotis*
Yarrukaddi	Tchingilli	cf. *Sminthopsis* sp.
Yelkamin	Walpari	*Bettongia penicillata*
Yenodin	Mudburra	*Tachyglossus aculeatus*
Yikowra	Wonkanooroo	*Dasyurus geoffroyi*
Yimala	Ilyowra : *e.* Arunta	*Rattus villosissimus*
Yiwutta	Arunta	*Onychogale lunata*
Yiwurra	Arunta : Ilyowra	*Isoodon* or *Perameles* sp.
Yowirri	Walpari : Warramunga : Tchingilli	*Macropus rufus*

APPENDIX 2

List of English vernacular names for the species discussed (in the order of the text).

Tachyglossus aculeatus	Echidna: Native porcupine
Dasyurus geoffroyi	Black tailed Native Cat
Phascogale calura	Lesser Brush Tailed Pouched Rat
Phascogale penicillata	Brush tailed Pouched Rat
Phascogale macdonnellensis	Fat tailed Pouched Rat
Phascogale ingrami	Ingram's Pouched Rat
Dasycercus cristicauda	Crest tailed Pouched Rat
Dasyuroides byrnei	Byrne's Pouched Rat
Sminthopsis crassicaudata	Fat tailed Pouched Mouse
Sminthopsis hirtipes	Hairy footed Pouched Mouse
Sminthopsis larapinta	Finke River Pouched Mouse
Sminthopsis murina	Slender tailed Pouched Mouse
Sminthopsis psammophila	Sandhill Pouched Mouse
Antechinomys spenceri	Western Hopping Pouched Mouse
Myrmecobius fasciatus	Banded Anteater
Thalacomys lagotis	Rabbit Bandicoot
Thalacomys minor	Lesser Rabbit Bandicoot
Isoodon auratus	Golden Bandicoot
Perameles eremiana	Desert Bandicoot
Choeropus ecaudatus	Pig footed Bandicoot
Notoryctes typhlops	Marsupial Mole
Trichosurus vulpecula	Brush tailed Opossum
Macropus rufus	Red or Plains Kangaroo
Macropus robustus	Hill Kangaroo
Petrogale lateralis	Black flanked Rock Wallaby
Onychogale lunata	Crescent marked Nail tailed Wallaby
Onychogale unguifera	Northern Nail tailed Wallaby
Lagorchestes conspicillatus	Spectacled Hare Wallaby
Lagorchestes hirsutus	Rufous Hare Wallaby
Lagorchestes asomatus	Central Hare Wallaby
Bettongia penicillata	Brush tailed Rat Kangaroo
Bettongia lesueuri	Burrowing Rat Kangaroo
Caloprymnus campestris	Plains Rat Kangaroo
Rattus villosissimus	Long Haired Rat
Rattus tunneyi	Tunney's Rat
Pseudomys minnie	Reese's Rat
Pseudomys fieldi	Field's Rat
Ps. (Thetomys) nanus	Little Rat
Ps. (Leggadina) waitei	Waite's Mouse
Laomys pedunculatus	Thick tailed Rat
Leporillus apicalis	White tipped House building Rat
Leporillus conditor	House building Rat
Notomys alexis	Brown Hopping Mouse
Notomys amplus	Brazenor's Hopping Mouse
Notomys cervinus	Fawn Hopping Mouse
Notomys fuscus	Wood Jones' Hopping Mouse
Notomys longicaudatus	Long tailed Hopping Mouse
Notomys mitchelli	Mitchell's Hopping Mouse
Hydromys chrysogaster	Water Rat
Canis familiaris dingo	Dingo: Wild Dog
Pteropus scapulatus	Collared Fruit Bat
Macroderma gigas	Ghost Bat
Nyctophilus geoffroyi	Geoffroy's Long-eared Bat
Eptesicus pumilus	Little Bat
Chalinolobus gouldi	Gould's Wattled Bat
Chalinolobus morio	Chocolate Wattled Bat
Scoteinus greyi	Grey's Broad nosed Bat
Scoteinus balstoni	Balston's Broad nosed Bat
Taphozous australis	Sharp nosed Bat
Taphozous flaviventris	Yellow bellied Bat
Nyctinomys australis	Free tailed Bat
Chaerephon plicatus	Wrinkled lipped Bat
Bos bubalis	Water Buffalo
Mus musculus	House Mouse
Rattus norvegicus	Brown Rat
Rattus rattus	Ship Rat
Oryctolagus cuniculus	Rabbit
Vulpes vulpes	English Fox
Felis cattus domesticus	Domestic Cat

ARCHAEOLOGICAL EXCAVATION OF NOOLA ROCK SHELTER: A PRELIMINARY REPORT

By Norman B. Tindale, Curator of Anthropology and Acting Director, South Australian Museum

Summary

On 2nd January 1961 Mr. Norman Blunden discovered Noola Rock Shelter on a south-facing wooded slope below a high cliff, on his grazing property near Rylstone, New South Wales. The site is near the eastern end of Portion 34 in the Parish of Tayar, County of Roxborough.

Acting partly on advice from the Chicago Museum of Natural History, Mr. Blunden wrote to the South Australian Museum for assistance in the study of the shelter, and, after some preliminary soundings of the floor had been made at our request, he offered us the privilege of the excavation of the site.

During preliminary tests he examined surface material to a maximum depth of 18in. over a part of the floor east of the centre. His first workings may be known as Excavation No. 1. At the lowest level reached there was a large rectangular slab of roof rock 6ft. in diameter, which effectively sealed off most of the deeper part of this portion of the shelter.

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In late April after arrangements for the main dig had been planned he dug a second, narrower trench (No. 2) at the approximate centre line of the shelter. This was carried down to a depth of 44in.; he took a photograph of the section for us. At some time during this second excavation Mr. John Bland was a visitor and took away a few duplicate specimens for his own collection.

On 22nd May 1961 the site was surveyed and Excavation No. 3 was begun by N. Blunden and the present writer, with the assistance of a team of eight voluntary helpers, Roy Braddock, Reginald Everson, Gilbert and June Grimshaw, Albert Mills, Barry Trounsen and Arthur and Margaret Williams. They worked in relays during the dig. The new hole extended outward from a datum point established on the back wall, 11ft. from the eastern extremity of the cave.

The cave itself is situated about 300ft. above the flood plain of Bogee Nile Creek, just west of a small side valley with a trickle of water running down from the base of the cliff. The long axis has a by complex geologic structure. Therefore it is only exceptional when mammalian fossils are sufficiently represented in a continuous succession of chronostratigraphic units to permit the delineation of Stages and Zones (Savage, 1955). One fauna may be distributed throughout a considerable thickness of rocks because of relatively rapid deposition of sediments. On the other hand due to a slow accumulation of detritus, or alterations in the distribution of animals, two or more distinct faunas may occur very close to one another in a vertical section. Locally or within an area of 50 miles, marshland, woodland and grassland environments may affect the composition of synchronous faunas. Some animals with wide environmental tolerances will frequently reveal the contemporaneity of such faunas. These synchronous assemblages of different composition (faunal facies) when discovered as fossils may be recorded by distinct faunal names.

We have recognized four faunas in the area here referred to as the Tirari Desert. A type locality has been designated for each of these faunas as is standard practice in introducing new formation names. To avoid confusion these have been given local geographic names that differ from the names of the formations. The reason for this is apparent because we have recognized two faunas, the *Malkuni* and the *Kanunka*, as coming from the Katipiri Formation. The *Malkuni* fauna is represented from numerous localities along Cooper Creek and at Lake Palankarinna. On the other hand we have found the *Kanunka* fauna in remarkably similar channel sands only at Lake Kanunka. Eventually one of our faunas may be discovered elsewhere in Australia in a different formation. The *Palankarinna* fauna is thus far restricted to two localities at Lake Palankarinna in the Mampuwordu Sands. Remains representing the *Ngapakaldi* fauna are more widely distributed. There are numerous localities at Lake Palankarinna, one at Lake Kanunka, and several at both Lake Pitikanta and at Lake Ngapakaldi.

STRATIGRAPHY AND VERTEBRATE PALEONTOLOGY

The term Tirari Desert was first used without explicit definition by John Walter Gregory (1906) for the sandridge country between the Warburton River and Cooper Creek occupied by the Tirari aboriginal tribe. As used in this report the Tirari Desert actually represents a southern extension of the Arunta (or Simpson) Desert east of Lake Eyre, bounded to the east by a north trending anticlinal axis involving Mesozoic and early Tertiary rocks. The southern boundary is the divide between the Lake Eyre and Lake Frome basins bearing of 300°, with its opening to the south. It protects a lenticular area 60ft. long and 15ft. wide at the centre line. It has an arched roof 10ft. high with a floor surface which slopes rather evenly down from the west to the east with a drop of about one foot in ten. Several large rocks cumber the floor and a larger mass over 60ft. long and 30ft. high lies below the shelter. It holds up a small plateau outside the cave entrance.

The excavation was made by removing 12in. squares of debris, each to a depth of 6in. The hole extended down to 96in. in a trench 4ft. wide and 8ft. long. The greater part of this area had been sealed off by the rock fall. A sieve of 0.2in. mesh was used.

Photographs, scale drawings and sections were prepared. Samples were obtained from each of 215 rectangles; these, plus all implements, pieces of bone and carbon samples, constitute the record. A running journal was made using a tape recorder. The excavations are to be continued.

This is a preliminary report on a few of the more interesting results achieved up to present time. The western half of the cave has been left inviolate for future study.

Specimens in the top layer, down to 18in., comprise a rich suite of microlith stone implements, including points of *bondi* and *woakwine* styles, geometric microliths, discoidal microlith adze stones, also bone points of two types, one sharp-pointed and the other of a slightly spatulate form. Edge-ground axes were obtained, one was just under the surface, and another battered and worn specimen, seemingly much mistreated during attempts to rejuvenate it by reducing its thickness, appeared just above the level of 18in.

Nine or more species of mammals seem to be represented among bones and teeth recovered in the first 18in. The remains of the flora above this level, in general seem to be those of the adjoining present-day bushland. Food remains include much burrawang (*Macrozamia*) husk. Evidently the nuts were an important article of diet. An abundance of emu egg shell suggests occupation at least during some winter months, for this is the stated general breeding season of these birds in the nearest area where they occur.

The occupational layers immediately below the rock seal were more compact and less productive. Stratification was very well defined. Microliths disappeared very soon. Bones were less common and generally absent at depths below about 4ft., except for a few teeth and some indeterminate fragments. Each occupational layer was denoted by a charcoal band.

A few large simple flakes, struck off from cores with a striking platform angle of about 120°, appeared below 40in. At 74in. there was the top surface of a large fire hearth, with masses of wood charcoal and ash which went down to 80in., where it rested on a prepared floor composed of many rounded stones. In the ashes of this fire, at 80in., was a characteristic, well-worked, large, high-backed flake implement, of a nosed graver type. Other less worked large flakes were recovered in adjoining layers.

Tentative assessment of the site suggests that an earlier occupation was by a people possessing an implement culture of the same type as in the carbon-dated sites at Tartanga in South Australia, at Cape Martin, and at Lake Menindee (Tindale 1955, 1957). The new find extends the range eastward beyond the limits of the Murray River Basin in this part of Australia. Noola Rock Shelter is near and east of the crest of the continental divide. It is situated at an elevation of about 2,000ft. above sea level. In Tartangan times it probably was not a place of very permanent residence, but rather one where brief visits were followed by long absences, when erosion products from the roof above supplied the bulk of the debris which accumulated on the floor. The early, well used hearth between 74 and 80in., provides the chief exception to this generalization. As one approaches the present surface there is a particularly sterile white band some 12in. thick, indicating virtual absence of visits, followed very suddenly by dense accumulations of occupational debris of the succeeding microlith using people. This occupation was more consistent and continued upward until the deposits merged with the veneer of present-day dust and debris on the surface of the cave.

Post-European disturbance was confined to droppings of sheep and cattle. In one place a rabbit burrow was cut across. This fortunately did not penetrate the compact lower levels, which were so hard as to require the use of a crowbar before they could be loosened for digging.

The upper occupational horizon has the general facies, and contents, of the Mudukian culture of the type locality at Devon Downs, (Hale and Tindale 1930), and of similar layers at Fromm Landing (Mulvaney 1960). However, consonant with the absence nearby of any rivers or deep streams which might have yielded fish, no *muduk* bone fishing toggles were present. A relatively great abundance of points, of types thought to have been used as needles in sewing skins together, may suggest that the altitude and southern exposure of the site was conducive to the use of skin cloaks and rugs. A homoclime of this place would be the Lower South-East of South Australia, where implements like these are abundant in Mudukian levels, as at Kongorong, and at Policeman Point on the Coorong.

The presence of axes, of a type remaining in use until modern times, is of interest. There is a similar, but hafted one in the South Australian Museum, from New South Wales, which shows use-polish on the handle. It is lashed with the red "turkey" twill cloth commonly traded to aborigines by the first settlers, hence must date to the very first days of contact, before metal axes were given to them.

The present writer's interpretation of the evidence found on several open air surface sites in South Australia, backed by C.14 dates, has been questioned by a few of those who feel that stratigraphy cannot readily be detected and evaluated, save in rock shelter and cave excavations. The discovery of this shelter is therefore of particular interest since is provides the kind of evidence considered most desirable, although it is clear to the present writer that, evaluated by one with training in stratigraphy, open air sites can yield data as equally useful as that likely to be afforded by intermittently inhabited caves.

The study of the site seems likely to go far to reinforce the claim for the existence of a Tartangan culture, earlier than the Mudukian. It may make more difficult rival interpretations which lately have arisen as a result of the increasing interest in the subject of archaeology in Australia. These matters will be more fully discussed when the Carbon 14 dates are available and the definitive account is prepared.

We are indebted to Mr. Norman Blunden for his interest in the excavation, for his assistance with equipment, his companionship and participation in the field work and for the gift of the specimens he collected in the earlier soundings. Whatever success has resulted is due to the efforts of the members of the team who worked together on the project.

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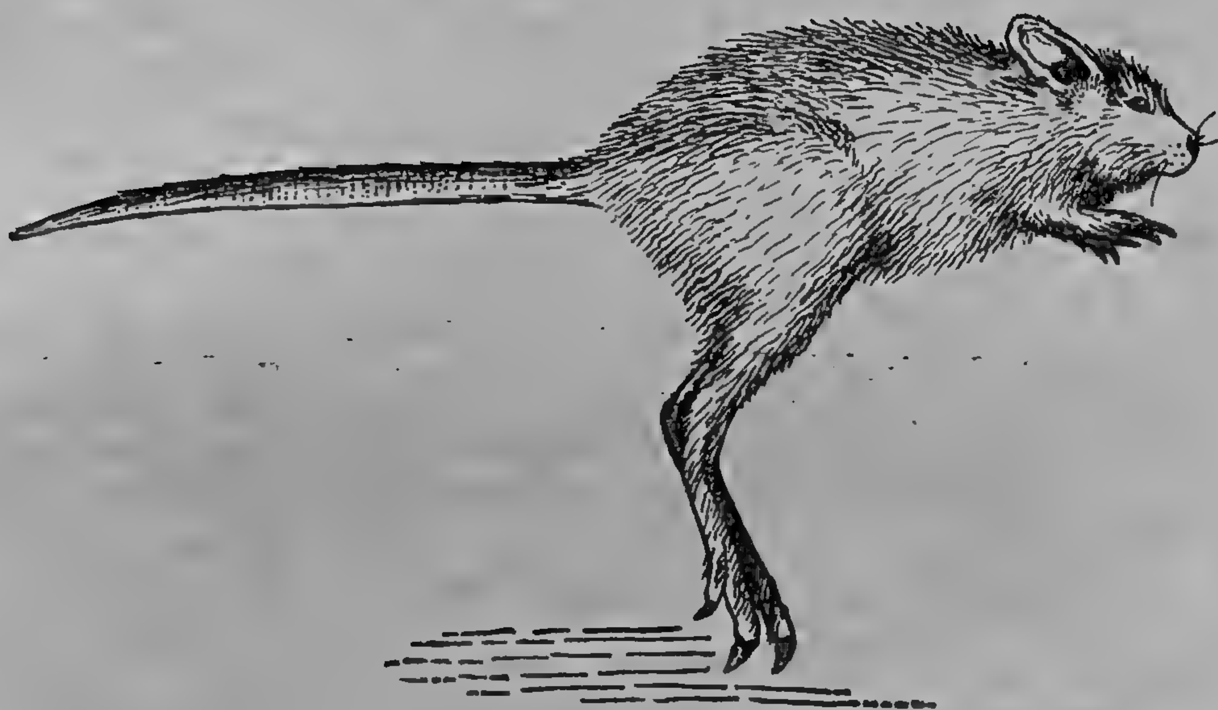
VOLUME 14 No. 2
1962



RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

Published by the Board and edited by the Museum Director

Printed in Australia by W. L. Hawes, Government Printer, Adelaide.

Registered in Australia for Transmission by Post as a Periodical.

THE PIGMY SPERM WHALE (KOGIA BREVICEPS) ON SOUTH AUSTRALIAN COASTS, PART III(1)

By Herbert M. Hale, Hon. Associate, South Australian Museum

Summary

Herein are described examples of Kogia not previously recorded from South Australia, with additional information concerning previous records. Following, under "Discussion" a comparative study of South Australian specimens is made from available data, including measurements, etc., concerning the exterior and the skulls.

The information so far recorded, herein and elsewhere, supports the view that only one species of Kogia exists. Further, while there are differences – sometimes considerable differences – between the skeletons of individual specimens, these as yet cannot be aggregated to provide satisfactory evidence that separate populations or schools occur. Nevertheless, examination of the features of a large number of specimens, when present at the time in given localities, could be illuminating.

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By HERBERT M. HALE, Hon. Associate, South Australian Museum

Plates 1-4 and text fig. 1-12

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INTRODUCTION

Below are listed the known strandings of *Kogia* on South Australian coasts, with record of the material recovered and placed in the South Australian Museum.

Pregnant adult female, April 25, 1937 (Reg. No. M.5009); and female suckling calf (M.5010); Port Victoria in Spencer Gulf. Half cast and complete skeleton of both. Male foetus, in formalin[2] (M.5011).

Unsexed example, August, 1944 (M.5197); Sleaford Bay, near Port Lincoln in Spencer Gulf. Skull, sternum and a few other bones.

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(1) See Hale (1947 and 1959) for parts I and II.

(2) Hale, 1947, pp. 534-536.

Adult female, August 7, 1957 (not recovered except for some teeth) with unsexed calf (M.6156); Sleaford Bay, near Port Lincoln in Spencer Gulf. Skull and portion of right ramus of lower jaw of calf.

Unsexed juvenile (not recovered[3]) and young male (M.6186); July 11, 1958, Largs Bay, in St. Vincent Gulf. Complete skeleton of M.6186.

Adult female and female suckling calf, June 28, 1959 (M.6256 and M.6257); Encounter Bay. Complete skeleton of both.

Adult male, September 29, 1959 (M.6266); Glenelg, in St. Vincent Gulf. Complete skeleton.

A mandible said to have come from Encounter Bay and noted by Wood Jones, is not included as an authentic South Australian record (Hale, 1947, p. 544).

My sincere thanks are due to Mr. A. Rau, who has enthusiastically assisted in the collecting of a number of small whales, and with his various assistants has prepared the skeletons of all examined by me.

To Miss M. Boyce I am indebted for the outline drawings and photographs of the skulls, sterna and tongue bones.

DESCRIPTION OF ADDITIONAL MATERIAL

FEMALE AND CALF (REG. NO. M.6156) SLEAFORD BAY, AUGUST 7, 1957. BODY LENGTH 1,700 mm.

The skull of the calf and portion of the right ramus of its mandible, as well as some of the teeth of both female and calf are available.

The stranding of these two examples was reported by Miss N. M. Follett, who, thirteen years before, and during the same month, August in mid-winter, reported the stranding of a *Kogia,* but here again the difficult terrain made it impossible to secure more than the skull and a few odd bones (Hale, 1947, p. 531).

For recovery of this second skull from Sleaford Bay I am grateful to the late Mr. W. C. Johnston, then of Port Lincoln, who, on request, visited the locality a few days later, took a few external measurements, and moved the bodies of both female and calf above high tide mark. Some time afterwards he was able again to make his way to Sleaford Bay but found both specimens partly eaten and badly damaged, apparently by foxes; he did, however, recover the skull of the calf

(3) Hale, 1959, p. 334, pl. XL.

and kindly brought it to the Museum. For some external measurements see p. 217 herein.

Skull

According to the flesh measurements supplied by Mr. Johnston the skull of this calf is distinctly less than seven times in the body length, measured correctly in a straight line from the notch in the tail to the tip of the snout.

The rostrum, from tip to anterior wall of left nostril, is not much less than half the total length of the skull.

The supraoccipital, when viewed from the side, is slightly convex but in general faintly sinuous; medianly it has a shallow gutter, which becomes evanescent as it approaches the foramen magnum; measured across its narrowest part, the supraoccipital is more than one and two-thirds times its length from the upper edge of the foramen magnum to the triangular apex, and the condyles are prominent, separated dorsally by a distance equal to one-half the length of the condyles. The foramen magnum is ovate (pl. 1, D) and is higher than wide.

The lateral surfaces of the maxillae are much as in most of the other skulls examined, the greatest depths being 43 mm. (left) and 32 mm.; the total length of the skull is 265 mm. The maxillo-malar sutures are indistinct on both sides, the malar and maxilla being fused; both sutures are sinuate, not descending steeply at about anterior third to form a decided V, but rather a shallow U. The length of the left suture is 77 mm., that of the right somewhat shorter. The maxillary crest is not elevated above the level of the upper edge of the supraoccipital and the suture between the occipital complex and the maxillae is quite open, as also are those between the maxillae and right premaxilla, which does not reach quite to the summit of the dorsal crest. The maxillary fossae are shallow dorsally but the borders begin to slope more abruptly to deepening fossae, at a point midway between the right nostril and the vertex. The prefrontal is narrow in front, not widely truncate as in calf M.6186, nor is it elevated above the right premaxilla on the opposite side of the right nostril. The anterior ends of both premaxillae appear on the palatal surface. The maxillary alveolar grooves extend back from the anterior end of the broad rostrum for a distance of 45-52 mm., that is almost to, or a little beyond, the middle of the length of the rostrum, from tip to the anterior margins of the palatines.

Teeth of female and calf. When Mr. Johnston first examined the mother and her calf M.6156, shortly after they were stranded at Sleaford Bay, he removed from both young and adult all the teeth he could discover. In the mandible of the female he found only fourteen, in that of the calf thirteen. As it is reasonable to suspect more to be present Mr. Johnston agreed to search further but, as aforementioned, the specimens had sustained considerable damage before his second visit.

The teeth from the female are stout, each approximately 30 mm. in length and most of them are very much more curved than those of an adult previously cast ashore at Sleaford Bay (Hale, 1947, fig. 11).

The longest of the teeth of the calf is 14 mm. in length. Two of the teeth are conjoined for five-sevenths of their length, the tips being free and separated.

For additional details see Discussion.

YOUNG MALE, LARGS BAY, JULY 11, 1958 (REG. NO. M.6186). BODY LENGTH 1,930 mm.

External Features

These are dealt with in part in a previous note (Hale, 1959, pp. 334-336, fig. 1-2). In describing the exterior of this example I recorded the fact that, although the body proportions approach those of suckling calf M.5010, "The snout is considerably shorter and has a more abrupt downward dorsal curvature, its tip being on a level with the eye". Also, the high dorsal fin was situated slightly in advance of the middle of the length of the animal.

As mentioned elsewhere herein, the snout anterior to the mouth is unusually short, being only 2.07 per cent of the total length of the animal, whereas in two other young specimens from South Australia the snout measured thus is 5.2 and 6.3 of the body length.

Skeleton

When the skull was subsequently removed and cleaned it was at once obvious that it was relatively much smaller than in other examples examined by me. In the last-named, the skull is at most barely more than seven times in the body length, usually less, whereas in M.6186 it approaches eight times in this length. The relatively short snout and small skull are associated with the more forward position of the dorsal fin in relation to the body length.

The rostrum of the skull of M.6186, from tip to anterior wall of left nostril, is decidedly less than half of the total length of the skull, thus being relatively short, as in female calf M.5010, from Port Victoria. The supraoccipital has a shallow and rather wide median gutter. Its upper margin medianly is only slightly produced and rounded, while the lateral margins curve gently downwards, so that the skull, as seen from the rear, presents a very different appearance to that of other skulls examined (pl. 2, C); the bone is more than one and one-half times wider than long. The occipital condyles are prominent, widely separated dorsally, the gap being equal to one and one-third times the height of the condyles. The foramen magnum is slightly obovate, almost circular (pl. 2, C), and is as wide as high. The squamosal and frontal are distinctly marked off from the occipital complex.

The lateral surfaces of the maxillae are unusually low, that of the right side, as measured from the posterior end of the maxillo-malar suture, is only 18 mm. and is decidedly lower than that of the left (26 mm.). The total length of the skull is 243 mm.

The maxillo-malar suture is very distinct and is S-shaped, the anterior part forming a deep V, most pronounced on the left side, where the length of the suture is 50 mm. as against 56 mm. on the right side. Both malars have the apex subacute and the greatest length of the left is more than one and one-third times the length, the right only one and one-half times the length.

The dorsal crest is not strongly elevated posteriorly and indeed reaches only to the level of the supraoccipital; anterior to this, however, it curves upwards to form a well elevated crest.

The maxillary fossae are deeper than in other South Australian calves, sloping steeply from the bordering wall. The prefrontal, truncate in front, forms a high thin crest between the nares, and is elevated above the level of the right premaxilla alongside the right nostril.

On the palatal surface the anterior ends of the premaxillae appear on both sides, the exposed portions being 9 mm. in length in both. On each side the maxillary alveolar groove extends back from the anterior end of the rostrum for a distance of 70 mm., approximately seven-tenths of the length from the apex of the short rostrum to the anterior margin of the palatines; as previously noted (Hale, 1959, p. 335), there are two small teeth near the anterior end of the rostrum. The width between the postorbital processes is greater than elsewhere in the skull.

The lower jaw has thirteen teeth in the right ramus, twelve in the left.

In the tongue bones (pl. 3, A) the basihyal is hexagonal, the anterior margin with a well marked U-shaped median incision, on each side of which is a short rounded cartilage. The ceratohyals are cartilaginous and the ossified portion of the stylohyals is longer than the thyrohyals. The latter are well separated from the basihyal by cartilage; each thyrohyal is much longer than wide and the bone is subcordate.

The sternum is not composed of three entire sections, but of four. The manubrium, apart from the cartilaginous portions, is not greatly expanded anteriorly, where its greatest width is only twice that of the posterior margin; there is no trace of a median suture and the whole bone is considerably wider than its length. The anterior margin has a rounded incision, as shown in pl. 4, A. The second segment is little less in length than the manubrium, as taken from the anterior notch of the last named, and has the anterior margin convex and the posterior obliquely inclined to the left of the animal; the above-mentioned plate shows the cartilage separating this and other ossified components. The third ossified segment is irregularly quadrangular in shape, the anterior margin inclined towards the left side of the animal. The fourth segment is small, wider than long and separated from the third by cartilage equal to its own length.

The cervicals, as in most examples of *Kogia*, form one solid mass, the height of which (87 mm.) is not much less than the greatest width (94 mm.); the spinous process is, in general, much as in Yamada's No. 5 example (1954, p. 48, fig. 8); similarly the dorsal process of the vertebrae is also relatively shorter.

The first of the fourteen thoracic vertebrae has the neural arch complete, the canal little wider than deep, and the dorsal spine less than one-fourth of the depth of the vertebra. In the last thoracic the dorsal process, measured from the upper margin of the neural arch, is slightly shorter than the distance between the venter of the centrum and the dorsal limit of the neural canal. In all of the ten lumbar vertebrae the dorsal process is decidedly shorter than the last-mentioned measurement. There are twenty-six caudals; there is no trace of paired metapophyses after the third caudal. The neural canal becomes an open groove on the fourteenth and is barely evident on the seventeenth.

There are fifteen chevrons; the members of the last pair are not united, those of the rest completely fused.

For additional measurements of skull see Discussion.

The ribs number thirteen on the right side, fourteen on the left. The anterior nine pairs have a double articulation.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	160	160
2	245	245
3	290	295
4	310	308
5	310	305
6	313	310
7	300	290
8	292	296
9	276	270
10	252	254
11	233	235
12	215	214
13	167	180
14	0	72

Thus the first twelve pairs are practically symmetrical, but the right rib of the thirteenth pair is decidedly shorter than the left, and abruptly shorter than the twelfth ribs. The last rib on the left side is rudimentary and was free of the vertebral column.

Remarks. As will be noted from the above description this young male is unusual in some respects, and is the only *Kogia* examined by me in which, notwithstanding careful search, any traces of the pelvis were found (Hale, 1959, p. 336).

FEMALE (REG. NO. M.6256) AND MALE CALF (M.6257), ENCOUNTER BAY, JUNE 28, 1959. BODY LENGTHS 2,980 mm. AND 1,892 mm.

On the abovementioned date it was reported that a young whale had "beached himself beside the body of his fatally injured mother". This instance evoked a graphic account of the urge of a suckling calf to remain with its mother under all circumstances (see also Hale, 1947, p. 531).

The female in this case became injured on a reef where, according to one observer, she "had been cut on rocks when scraping barnacles from her body. She made for the beach, grounded and was stuck".

Another of the witnesses of the strandings, Mr. G. H. Rumbelow, of Encounter Bay, stated: "We did our best to save the calf by driving him out to sea. Some of the onlookers dragged the mother whale on to the beach, but the calf wouldn't leave. It went out to the reef but came in again and ran itself on to the shore."

Early next day Mr. A. Rau, with two other members of the Museum staff recovered both specimens, which, as suspected from descriptions given, proved to be *Kogia*, and brought them to the Museum; thus they were examined about eighteen hours after death, with the colouration presumably not greatly affected by recent stranding. The specimens had not been subjected to sunlight but had been cut about by visitors during the night. However, with exception of the dorsal fin of the calf, all parts were recovered; the dorsal fin of the female had been cut off, and also some of the adjoining flesh of the back, so that, while the fin itself was in perfect condition, it was not possible to ascertain with certainty its position in regard to the total body length.

The admittedly meagre evidence available seems to indicate that when the sluggish Pigmy Sperm Whale becomes injured, or even touches bottom, in shallow waters, it immediately makes its way to the adjoining beach. This may apply to other whales, particularly the smaller species, *Mesoplodon, Berardius* (Hale, 1939, p. 5), etc.

External Features of Female

The colour of the female was light blue-grey above and white below; the dorsal colour was, in fact, much paler than in any other of the examples seen by me. The white of the lower portions extended upwards to about three inches below the eye and included the lower half of the depth of the snout. In the caudal area the white was restricted to the underside, the sides and dorsum being pale blue-grey.

The body was fully four and one-fourth times its greatest depth. The head was deep, with the snout blunt and rounded (fig. 8); the blowhole was large, 85 mm. in width, crescentic and oblique, the left end of the opening 250 mm., in vertical level, from the tip of the snout, the right end 275 mm.

The falcate dorsal fin (fig. 12) was long and low, its length (400 mm.) four and three-fourths times the height, and 13.3 per cent of the total length of the animal. The pectoral limbs (fig. 3) were rather slender, two and two-third times as long as deep. The dorsal keel of the tail terminated 45 mm. in advance of the narrow caudal notch, and the width of the flukes was relatively less than in the adult male No. M.6266 (see figs. 1 and 5 herein).

For additional measurements of exterior and skull see under Discussion.

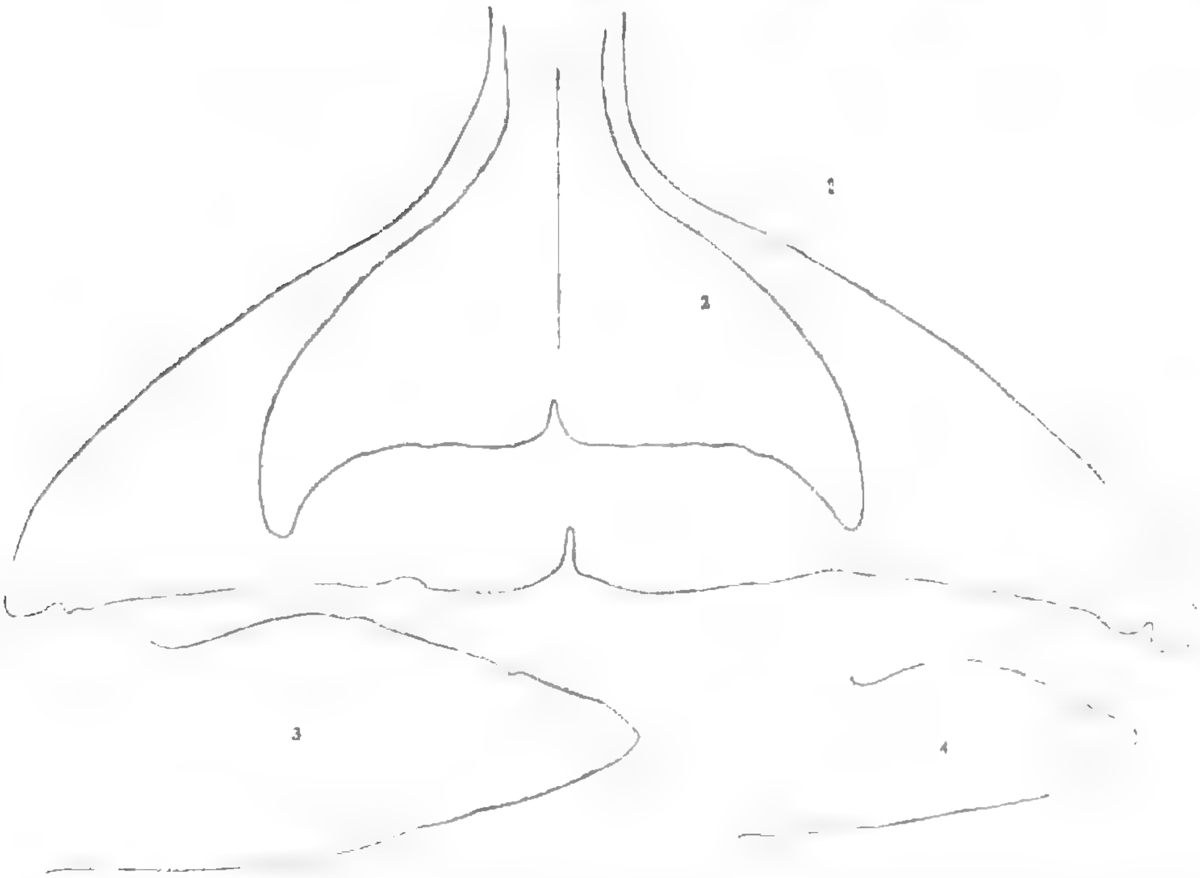

Fig. 1-4. Aged female and her male calf, Encounter Bay; 1-2, caudal fins; 3-4, pectoral fins (1/6 nat. size).

Skeleton of Female

The skull is very slightly less than one-seventh of the total length of the animal. The rostrum, from its tip to the anterior wall of the left nostril, is relatively distinctly longer than in the young calf accompanying M.6256, being more than half the total length of the skull, viz., 1.7 in length of skull. The supraoccipital, as seen from the side, is concave, and has a well defined groove on the upper three-fourths of its length; its dorsal margin is broadly triangular medianly, where it is 9 mm. below the top of the maxillary part of the crest, the premaxillary part being a trifle more elevated; from the median angle the lateral margins curve outwards and only slightly downwards; the narrowest width of the bone is a little less than one and three-fourths the height, measured as in other examples recorded herein from the upper margin of the foramen magnum to the triangular dorsal apex.

The prominent occipital condyles are separated widely dorsally, the height of the condyles being little more than one and one-half times the width of the gap; ventrally the condyles are separated by a distance equal to only one-third of the dorsal gap. The foramen magnum is obovate, very little higher than wide (pl. 2, A). The lateral faces of the maxillae, above the maxillo-malar suture, are deep, 80 mm. on left side, 54 mm. on the right. The distinct maxillo-malar suture is irregularly triangular, curved downwards posteriorly for only a very short distance.

The dorsal crest is strongly elevated posteriorly with, as already noted, the premaxillary element slightly elevated above the maxillary part. The maxillary fossae are deep, sloping steeply from the narrow borders.

The prefrontal is nearly half the length of the rostrum as measured from tip to anterior wall of left naris and is elevated as a crest above the level of the premaxilla alongside the right nostril.

The anterior ends of the premaxillae appear on the palatal surface for a length of 87 mm., which is equal to one-half of the distance between the tip of the rostrum and the anterior margin of the palatines; the maxillary grooves are 115 mm. in length on both sides, about half the length of rostrum measured as above. No upper teeth were present.

The rami of the mandible are firmly fused anteriorly for a distance of 87 mm. but the tips are narrowly separated to a length of 10 mm.; the distance between the condyles is about six-sevenths of the mid-line length of the jaw. There are fourteen teeth in the left ramus, thirteen in the right; they are only slightly curved and the anterior nine or ten have the tips worn and blunted in varying degree.

In the tongue bones (pl. 3, B) the basihyal is hexagonal, distinctly wide than long, and with the anterior margin bisinuate, and capped with a short, irregular cartilage, while the posterior margin is concave. The cartilaginous ceratohyals are much shorter than the ossified portions of the stylohyals. The thyrohyals are much shorter than the stylohyals, and are suboval in shape; the bony plates are fused to the basihyal, leaving a jagged gutter for the greater part of the length on both surfaces, the gutters being filled with cartilage.

In the scapula the acromion is curved to an unusual degree and in both left and right almost touches the coracoid; the calf of this female has the acromion and coracoid well separated distally, the first-named showing only slight curvature.

The sternum (pl. 4, B, ventral view) consists of three segments, all entire, while the sternum as a whole has a distinct curvature towards the left side of the animal. The manubrium is fully one-fourth as wide again as long and its anterior edge has a deep notch, nearly one-third of the length of the bone; above the notch the anterior margin is rounded, then sweeps steeply down to the lateral ends of the wing-like expansions of the distal half; the second segment has markedly concave sides and is as long as the distance between the posterior margin of the manubrium and the terminal end of its median anterior notch; the third is short and very irregularly quadrate.

The cervicals form a solid mass, with the dorsal process high; the cervicals closely resemble those of Yamada's No. 6 specimen (1954, p. 48, fig. 8).

In the first and second of the thirteen thoracic vertebrae the neural arch is broken. The dorsal process of the last thoracic, measured, as always herein, from the upper limit of the neural canal, is one and one-third times the distance between the ventral keel of the centrum and the apex of the narrowly triangular canal, while it is nearly three-fifths of the total depth of the vertebra.

The eighth of the nine lumbar vertebrae has the dorsal process even shorter than in Yamada's photograph of this vertebra in his No. 5 (fig. 9, right), and the dorsal spines of all lumbars are relatively short as compared to Yamada's example No. 6.

In the twenty-three caudal vertebrae the neural canal becomes a completely open groove on the twelfth, whereas it is entirely roofed over on the eleventh. Metapophyses are not apparent after the fourth caudal. There are thirteen chevrons, the components of all united.

There are thirteen ribs on the right side, twelve on the left; the greatest lengths of the bony portions, where not damaged, are given below.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	282	290
2	415	420
3	483	483
4	500	505
5	490	500
6	485	485
7	Broken	480
8	452	452
9	420	420
10	Broken	390
11	Broken	359
12	255	255
13	101	0

External Features of Male Calf

The colouration was exactly as in the mother; the white of the underside reached to within two inches below the eye.

The snout was, relatively, longer than that of the female, and tapered to a blunt point (fig. 9); this difference in the shape of the snout in mother and calf was apparent also in a previous record (Hale, 1947, pl. XIV). The distance between the tip of the snout and the axilla was a little greater, proportionately, than in the female.

As in the mother the blowhole was wide (65 mm.), crescentic and oblique; in vertical level the left end of the opening was 183 mm. from the tip of the snout, the right end 205 mm. The pectoral limbs were fully two and two-third times as long as greatest width (fig. 4).

The dorsal keel of the tail terminated 30 mm. in advance of the narrow median notch; the flukes were relatively not as wide as in the mother and swept backwards to a greater degree (fig. 2).

Skeleton of Male Calf

The skull is a little less than six and one-half times in the total length of the animal. The rostrum, measured from the tip to anterior wall of left nostril, is little less than half the length of the skull. The occipital complex (supraoccipital) has a shallow median depression for about three-fourths of its length, expanding downwards from the apex and with an irregular median tuberosity towards its ventral termination; the upper margin is medianly triangular, the apex of the triangle 10 mm. below the top of the maxillary part of the dorsal crest; from the median portion the lateral margins curve outwards almost horizontally, much as in the male calf from Largs Bay (M.6186), but this example differs in the decided median triangular dorsal elevation (cf. pl. 2, B and C); the bone, measured from the upper margin of the foramen magnum to the triangular dorsal apex, is slightly more than one and three-fourths wider than long, with the breadth measured across the narrowest part. The rather prominent occipital condyles, as in the mother (M.6256) are widely separated dorsally, the height of the condyles being little more than one and two-third times the width of the gap; ventrally the condyles are separated by slightly more than one-fourth of the dorsal gap. The foramen magnum is obovate, angular dorsally and is one and one-fourth times higher than wide (pl. 2, B). The lateral surfaces of the maxillae, above the maxillary-malar suture, are deep (50 mm.) on the left side, but distinctly lower, 35 mm., on the right. The maxillo-malar suture is distinct, irregularly triangular and curved downwards posteriorly for only a very short distance.

The dorsal crest is strongly elevated posteriorly, the pre-maxillary portion a little lower than the maxillary elevations. As in the mother the maxillary fossae slope deeply inwards from the narrowly rounded bordering walls.

The prefrontal is, as usual, truncate and slightly excavate anteriorly when the cartilage is removed; it is much shorter than in the mother, with the crest between the nares not elevated above the level of the premaxilla alongside the right nostril.

On the palatal surface the anterior ends of the premaxillae appear for a length of 30 mm., one-fourth of the distance between the tip of the rostrum and anterior margin of palatines. The maxillary grooves are 65 mm. (left) and 70 mm. in length, much less than half the length of the rostrum, measured as above. There are no upper teeth, but in the lower jaw there are fourteen in the right ramus, thirteen in the left; the teeth are as in a female calf previously illustrated (Hale, 1947, fig. 10), slightly curved and with the tips feebly hooked; the longest is 15 mm. in length, the shortest almost 14 mm.

The distance between the condyles of the rami, which are not fused anteriorly, is not much less than the mid-line length of the mandible.

The bony parts only of the tongue bones are before me, the cartilaginous portions having disappeared during maceration. The basihyal is broadly hexagonal, wider than long and with the anterior margin narrow and slightly oblique, with no suggestion of a median incision; the stylohyals are one-third longer than the oval thyrohyals.

The last of the presumably three stenebrae is missing but obviously was present. The cartilaginous parts of the sternum are not available, even in part, but in the bony portion of the manubrium the greatest length is equal to the greatest width and not much less than twice the width of the posterior margin; the anterior median notch is wide, angular at posterior end, and is not quite one-twelfth of the greatest length of the manubrium; from the anterior notch the lateral borders curve downwards and inwards on each side to form semi-circular wing-like projections; the two components are completely fused, but with some trace of a median suture, and the transverse posterior margin is equal to a little more than half of the length as measured from the end of the anterior notch. The second stenebra consists of one bone, with the lateral margins concave and the anterior margin inclined to the right; it is widest anteriorly, where it is seven-tenths of its greatest length, the latter being five-sevenths of the greatest length of the manubrium.

The cervicals are not fused into one solid mass, the centrum of the seventh being quite separated from that of the sixth cervical;

the epiphyis of the posterior end of the centrum of the sixth cervical and both the anterior and posterior epiphyses of the seventh are completely free; the dorsal process of the cervical vertebrae is relatively long, as in Yamada's No. 6 example (1954, p. 48, fig. 8) and tapers to an acute dorsal point.

The first of the fourteen thoracic vertebrae has the neural arch complete, the canal wider than deep, and the acute dorsal spine more than one-fourth of the depth of the vertebra. The dorsal process of the last thoracic, measured from the upper margin of the neural canal, is almost one and three-tenths times the distance between the ventral keel of the centrum and the dorsal end of the triangular canal, and is distinctly more than half the total depth of the vertebra.

In the nine lumbar vertebrae the eighth (to compare with Yamada's photographs of this vertebra: fig. 9, right) has a dorsal process much longer than in Yamada's No. 6 example.

The dorsal processes of the twenty-four caudal vertebrae are progressively shorter than those of the lumbars. On the thirteenth caudal the neural canal becomes an open groove, with the merest indication of the neural arch. No trace of paired metapophyses are obvious after the fourth caudal.

There are thirteen chevrons; the small components of the last pair are free, those of the rest united.

For additional details of external features and skeleton see Discussion.

There are thirteen ribs on the right side, fourteen on the left; the twelfth to fourteenth ribs on the left side are short and were separated from the vertebral column by cartilage equal to their own length.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	162	164
2	240	242
3	280	280
4	280	285
5	284	288
6	285	284
7	271	269
8	255	Broken
9	242	245
10	225	225
11	215	211
12	194	163
13	Broken	81
14	73	0

ADULT MALE, GLENELG, SEPTEMBER 29, 1959 (REG. NO. M.6266). BODY LENGTH 2,730 mm.

This example was stranded at Glenelg early on the morning of the abovementioned date and, thanks to the assistance of the Glenelg Corporation, was loaded on to the Museum truck and reached the Museum a couple of hours later. It was thus the only South Australian example to be examined so soon after death—in fact it was still warm when received.

External Features

The disposition of the colours seemed to be much as in the photographs of a calf previously published (Hale, 1959, p. 334, pl. XL). It differed, however, in that the back was dark grey, much darker than in the female and calf from Encounter Bay, taken three months before. The white of the underside extended to about one inch below the eye; there was no sharp demarcation of the two colours. From the level of the anus to the end of the tail the colour was dark grey, both

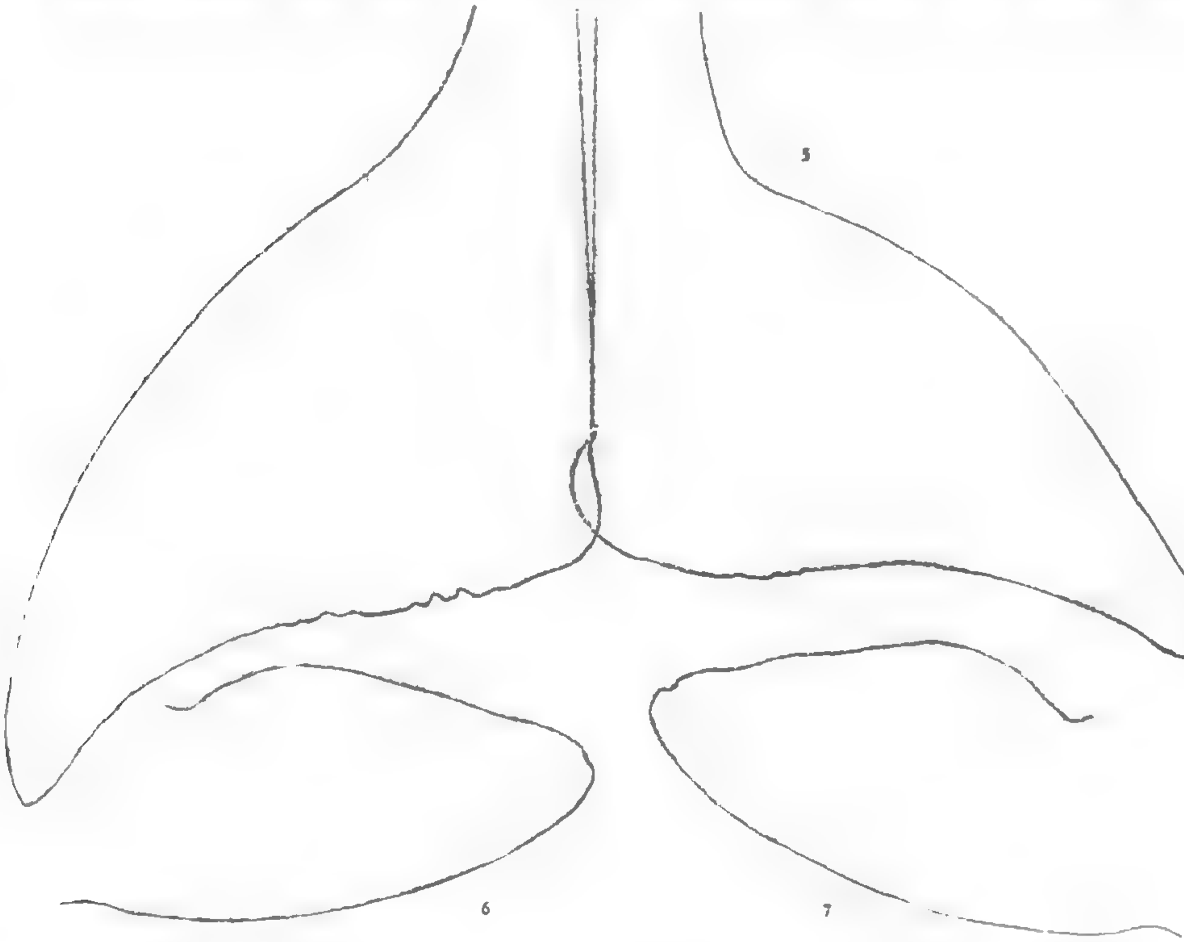

Fig. 5-7. Adult male, Glenelg; 5, caudal fin; 6-7, left and right pectoral limbs (⅙ nat. size).

above and below, except for a white median patch on the underside of the tail. The pectoral limbs were white below, merging at edges into the dark grey of the outer faces.

The body was more than four times its greatest depth. The head was deep and blunt (fig. 10); the snout, anterior to the gape, was shorter than in the adult female M. 6256, the last-named being of approximately the same body length; the blowhole (42 mm. in width) was crescentic and markedly oblique, the left end of the opening 315 mm., in vertical level, from the anterior end of the snout, the right end 337 mm.

The relatively large falcate dorsal fin (fig. 11) originated only slightly behind the middle of the body length and was more than three times as long as high. The pectoral limbs were nearly three times longer than wide (fig. 6-7). The dorsal keel of the tail terminated at the median caudal "notch"; posterior to the dorsal keel, however, the flukes overlapped for a length of 60 mm. and, at greatest width, for 17 mm. (fig. 5), a condition not occurring in other examples examined.

For additional notes on the exterior and of the skull see under Discussion.

The Skeleton

The skull, 420 mm. in length, is six and one-half times in the body length. The rostrum, from tip to anterior wall of left nostril, is decidedly more than half the total length of the skull. The supraoccipital has no median gutter and seen from the side is markedly concave; it is relatively very wide, its narrowest breadth nearly twice the height from the upper margin of the foramen magnum to the apex; medianly its dorsal edge is broadly subtriangular and does not reach the level of the posterior end of the dorsal crest. The occipital condyles are prominent, widely separated dorsally by a distance equal to half their height; ventrally the condyles meet. The foramen magnum is oval in shape, its height nearly one-third greater than its width (pl. 2, D).

The distinct maxillo-malar suture is sinuate, its anterior portion straight and running subparallel to the lower edge of the malar for a distance equal to more than half the length of the latter; thence it rises in the form of a wide U, which soon recurves to meet the frontal.

The dorsal crest posteriorly is elevated and broad. The maxillary fossae are deeply excavate, sloping steeply from the rounded edges of the bordering wall. The prefrontal is long, due to the fact that anteriorly the ossification of the cartilage has proceeded considerably further than in the skulls of the calves described herein: it is truncate at the anterior end, from which it rises steeply, the posterior portion forming a thin crest rising between the nares to above the level of the right border of the left nostril.

The anterior ends of the premaxillae appear on both sides of the palatal surface for a distance of 60 mm. The maxillary alveolar grooves are 130-135 mm. in length, a little more than three-fourths of the distance between the anterior end of the broad rostrum and the front margin of the palatines.

The width between the condyles of the rami of the lower jaw, which are firmly fused at the symphysis for a distance of 50 mm., is little less than the mid-line length of the mandible. There are no teeth in the upper jaw but in the lower there are fourteen teeth on the left side and fifteen on the right; the curvature of the teeth is as in an adult female previously figured (Hale, 1947, fig. 11), and they are subequal in size, 28-32 mm. in length.

The basihyal of the tongue bones (pl. 3, C) is slightly notched anteriorly, a little wider than long and with the posterior margin irregularly serrate; on each side of the anterior notch of the basihyal is a small rounded cartilage; the cartilaginous ceratohyal is relatively much shorter than as shown in Benham's figure (1902, pl. iii), possibly due to the fact that the ossification of the stylohyal is more advanced and that his ceratohyal represents, in the distal part, the proximal end of the stylohyal; in M.6266 the ossified parts of the stylohyals are one-fourth longer than the bony portions of the thyrohyals; the latter are irregularly semicircular in outline, with the outer edges convex and smooth, the rest of the bony margin irregularly serrate, while, as shown in pl. 3, C, they are well separated from the basihyal by cartilage.

The sternum (ventral view, see pl. 4, C) is composed of three stenebrae, but only the anterior two are entire, the left side of the last, unfortunately lost before the photograph was secured, was wholly cartilaginous, but of the same shape and size as its opposite ossified member. The manubrium is greatly expanded anteriorly, where its greatest breadth is three times that of the posterior margin and more than its length; there is a tiny anterior incision at the middle of the anterior margin, but no median suture, although tiny foramina occur on the mid-line. The second segment is less than the length of the manubrium from posterior margin to anterior notch, while the ossified portion of the third is barely more than one-third the length of the second and is irregularly subquadrate.

B

The rest of the skeleton was examined *in situ* after partial dissection of the animal. The cervicals are fused into a solid mass; the dorsal process is short as in Yamada's No. 5 example (1954, p. 48, fig. 8, upper) but as seen from the side its shape is very different, the dorsal end forming a broad obtuse angle, with little backward inclination; the fused epiphysis of the seventh is concave and fits firmly against the attached ephiphysis of the first thoracic. These epiphyses are both eroded in the centre as if an abscess had been present.

The first of the twelve thoracic vertebrae has a complete neural arch, with its canal one and three-fifths times wider than deep; the acute dorsal spine, as measured from the upper margin of the neural arch, is short, less than one-fifth the height of the vertebra. The dorsal process of the last thoracic is nearly one and one-quarter times the distance between the ventral keel of the centrum and the dorsal end of the narrowly triangular neural canal, and is a little more than half of the total depth of the vertebra. The eighth of the nine lumbar vertebrae has the dorsal process (measured from dorsal end of neural canal) one-half of the total depth of the vertebra.

As usual, the dorsal processes of the twenty-five caudal vertebrae become progressively shorter, the neural canal becoming an almost open groove on the twelfth, the two sides of the neural arch nearly meeting on this vertebra. Metapophyses disappear on the sixth caudal. There are only eleven chevrons; the members of all are united. It should be mentioned that maceration was carried out very carefully, evidenced by the fact that even the tiniest caudals are preserved.

For further comparative details see under Discussion.

There are twelve ribs on each side; excepting the last, the greatest length of the bone in each pair is almost uniform, as shown in the following table.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	256	256
2	393	390
3	434	437
4	445	455
5	450	458
6	462	465
7	455	455
8	430	430
9	400	400
10	365	365
11	340	340
12	320	312

Food

The thick-walled and internally strongly convoluted first compartment of the stomach contained beaks of a Cephalopod, identified by the Curator of Molluscs, Mr. B. C. Cotton, as belonging to a squid (*Sepioteuthis australis*); in addition there were portions of the exoskeleton of long-tailed Decapod crustaceans, including parts of a Peneid prawn, and ligaments from a kangaroo. For identification of these last I am indebted to Mr. I. Thomas, Department of Zoology at the University of Adelaide; they probably represent the remains of bait used by cray-fishers or big-game fishermen. The rest of the stomach contained a large volume of thick soupy matter, stained almost black with sepia from the ink sacs of the squids, while the contents of the intestine throughout were similarly coloured. According to Mr. Cotton *Sepioteuthis* may occur in schools, in which case this *Kogia* had encountered, shortly before its death on a sandy shore, such a swarm, as around the mouth there were many shallow, freshly made short cuts, in addition to other healed scars. The diet of *Kogia* is obviously varied (see also Hale, 1947, p. 544 and Scheffer and Slipp, 1948, p. 308).

Parasites

There were numerous barnacle scars on the body, behind the pectoral fins and extending as far back as the anus.

Amongst the food remains in the first compartment of the stomach was a mass of nematode worms. As usual in specimens examined by me in the flesh tapeworm cysts were imbedded in the flesh.

Edible Qualities

Seven people requested beef from the carcass of this male. They reported that it constituted an excellent hot meal and provided some of the most tender steak they had eaten. This notwithstanding the fact that the specimen had not been bled and had been dead for 24 hours or so when fleshing was commenced. It was noted further that the steaks when cold were not so palatable and in fact then had little appeal as food. Hubbs (1951, p. 409) reports that "the staff of Scripps Institution and friends ate a large part of the deep-red flesh of the pygmy sperm whale" captured on a beach in California, and notes their reactions. In Japan the species is utilized as food whenever it is taken.

DISCUSSION

Season of Strandings

Glover Allen (1941, p. 23) writes "what significance may be attached to the fact that most of the North Atlantic records are for the cooler months of the year is uncertain".

In Japan, Yamada (1954, p. 53) notes that "The appearance of kogiids off Taiji is confined to the trying summer season probably due to their migrating habit". Gunther, Hubbs and Beal (1955, p. 268), suggest that there may be a northward movement, in the northern hemisphere, between autum and spring. They write, "It is quite possible that the pygmy sperm whale, like some of the larger cetaceans, moves rather far towards the poles, in the summer, to feed on the rich pelagic food supply of those regions, returning to warmer waters to breed." Hubbs (1951, p. 409) earlier discussed the distribution of *Kogia*.

The examples which have been beached on South Australian coasts have come ashore during the colder half of the year. The dates of strandings indicate that *Kogia* is present in South Australian waters at least between late April and late September; also that during this period calves as well as adults of both sexes occur. For example in July, 1958, two young specimens (Hale, 1959, p. 333) were noticed in St. Vincent Gulf, and soon came ashore at Largs Bay. From early in June, 1959 (winter) until September (spring) of the same year fishermen and others reported that small whales with blunt heads were seen travelling slowly to and fro along the coasts of Encounter Bay and St. Vincent Gulf. During this period a female and her calf were stranded at Encounter Bay, while three months later an adult male (M.6266) came ashore in St. Vincent Gulf (see also Hale, 1947, p. 532). Most of the South Australian strandings occurred during calm weather.

According to published records *Kogia* has been cast ashore in New South Wales (south of lat. 30 S) during August and September. On the other hand the similarly few dates of New Zealand strandings extend well into the summer season, August to late January (Oliver, Proc. Zool. Soc., London, 1922, p. 567).

External Characters

Boschma (1951, p. 12) has called attention to the fact that more exact knowledge of the external features of *Kogia* is desirable.

Unfortunately, in relatively few strandings is it possible for the worker to bring the whale to his institution before post-mortem changes have resulted in change of colour, or, as is so often the case, before a stranded or captured *Kogia* is mutilated. Naturally, strandings of whales, large or small, are most often reported from populated areas, and before an animal is recovered, even after a lapse of only a few hours, vandals have time to mutilate it. However, I have been fortunate in being able to examine at the Museum a few whole specimens. Some external measurements of these follow, together with meagre data provided from another source.

External measurements of young male (M.6186[4]) and adult male (M.6266) from Largs Bay and Glenelg, St. Vincent Gulf.

Measurements.	M.6186.		M.6266.	
	mm.	per cent.	mm.	per cent.
Total length to notch of tail flukes	1,930	100	2,730	100
Greatest depth of body	440	22.7	630	23.0
Tip of snout to vertical level of anterior corner of eye	180	9.3	372	13.6
Tip of mandible to vertical level of anterior corner of eye	140	7.2	275	10.0
Tip of snout to vertical level of anterior end of base of dorsal fin	930	48.1	1,430	52.3
Tip of mandible to axilla	386	20.0	680	24.9
Width of flukes	475	24.6	763	27.9
Height of dorsal fin	155	8.0	152	5.5
Length of base of dorsal fin	220	11.4	510	18.6
Greatest length of pectoral fin	300	15.5	350	12.8
Greatest width of pectoral fin	105	5.4	165	6.0
Length of gape to posterior fold	119	6.1	152	5.5
Length of eye	24	1.2	30	1.1
Depth of eye	13	0.6	15	0.5

External measurements of two adult females and their calves. M.6156, calf (sex ?) of Sleaford Bay female; M.6256 and 6257, female and male calf from Encounter Bay[5].
(Measurements of Sleaford Bay examples as supplied by Mr. W. L. Johnston.)

Measurements.	♀ Not recovered.		M.6156.		M.6256.		M.6257.	
	mm.	per cent.	mm.	per cent.	mm.	per cent.	mm.	per cent.
Total length to notch of tail flukes	2,925	100	1,720	100	2,980	100	1,892	100
Greatest depth of body	665	22.7	450	26.1	665	22.3	475	25.1
Tip of snout to vertical level of anterior corner of eye	—	—	—	—	400	13.4	270	14.2
Tip of mandible to vertical level of anterior corner of eye	238	8.1	—	—	235	7.8	150	7.9
Tip of mandible to axilla	—	—	—	—	658	22.0	450	23.7
Width of flukes	660	22.5	415	24.1	750	25.1	378	19.9
Height of dorsal fin	115	3.9	—	—	110	3.7	—	—
Greatest length of pectoral fin	355	12.1	—	—	405	13.6	260	13.7
Greatest width of pectoral fin	140	4.7	—	—	150	5.0	95	5.0
Length of gape to posterior fold	—	—	—	—	190	6.3	123	6.5
Length of eye	—	—	—	—	30	1.0	25	1.3
Depth of eye	—	—	—	—	10	0.3	12	0.6

(4) See also Hale, 1959, pp. 334-335.

(5) See also Hale, 1947, p. 535, for measurements of another cow and her calf.

Length of Snout. The length of the snout, anterior to the tip of the lower jaw, is very variable in length. In the South Australian specimens measured in the flesh the snout of juveniles, 1,710 mm. to

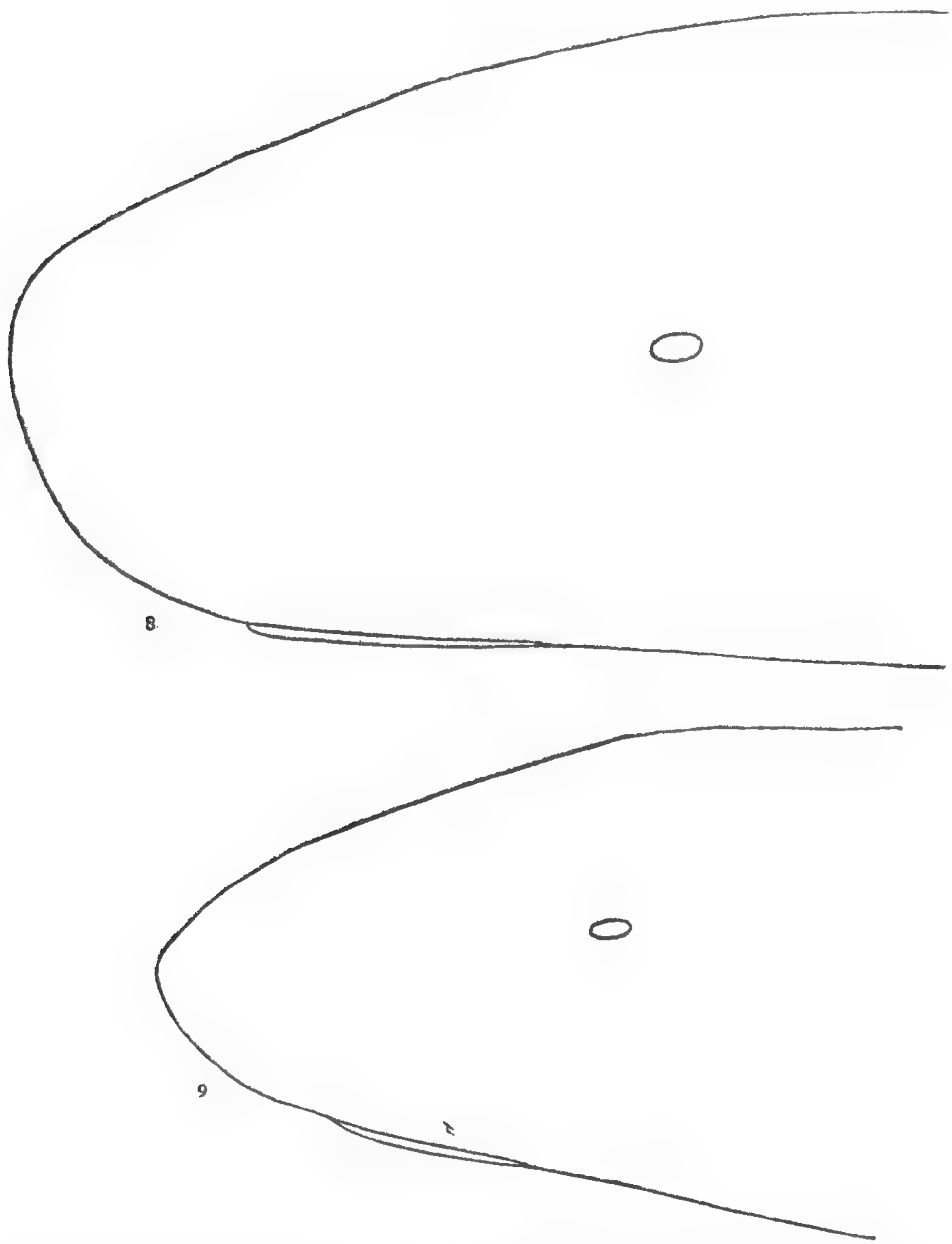

Fig. 8-9. Heads of aged female and her male calf, Encounter Bay (1/5 nat. size).

1,930 mm. in body length, varies from 2.0 to 6.3 per cent of the body length; the first named, 2.0 per cent, is extreme, as mentioned elsewhere herein. In adults of both sexes from southern Australia, 2,730 mm. to 2,980 mm. in body length, the proportion ranges from 3.5 to 5.5, and this ratio has no relation to sex. The snout length in relation to skull length also has no bearing on size or sex.

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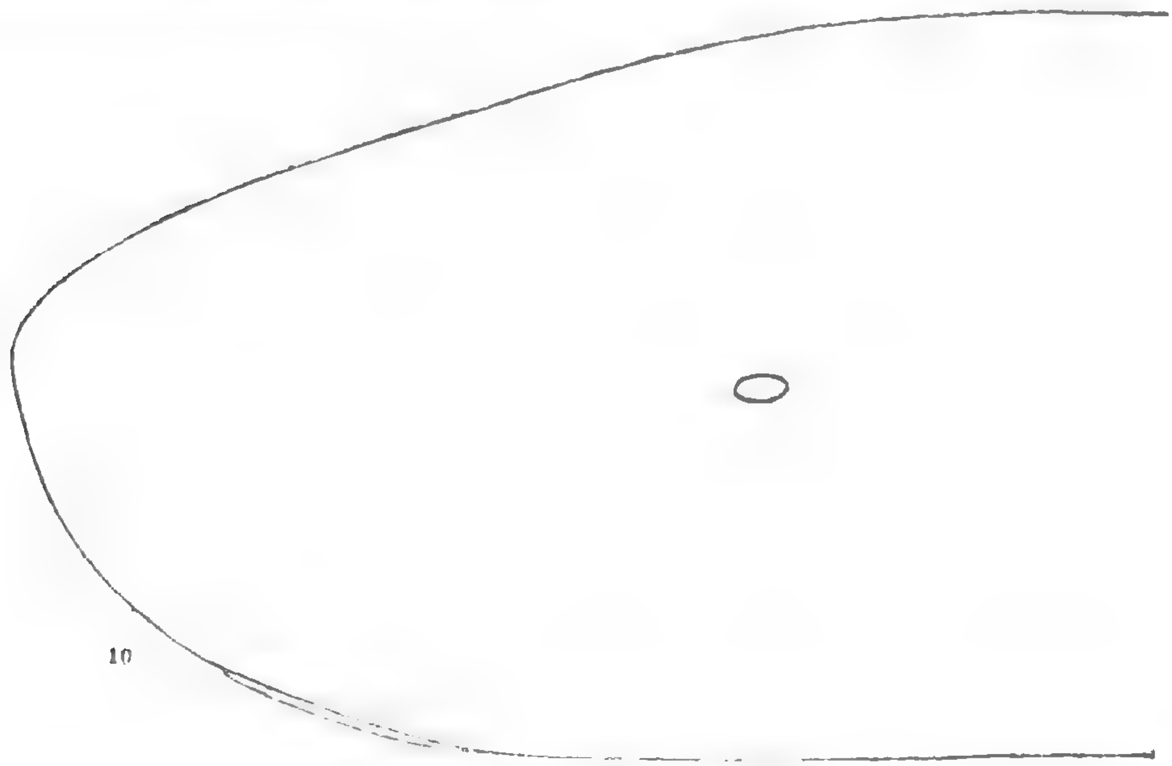

Fig. 10. Head of adult male, Glenelg (1/5 nat. size).

Yamada (1954, p. 41) provides measurements of some Japanese examples. These also show differences in the snout length, this varying in two females, of approximately the same size, from 3.3 to 4.0 per cent of the body length.

Thus the length and shape of the snout provide no clear indication either of age, sex or locality. The variation may be due at least in part to the degree of development of the mass of the spermaceti organ, which Glover Allen (1941, p. 26) suggests "possibly acts as a bumper or shock absorber in head-on contacts . . ."

Dorsal Fin. From available data the dorsal fin originates slightly posterior to the middle of the total body length of the animal, or a little in advance of the middle of the body length. Care is necessary to ascertain as closely as possible the most anterior point of the base of the fin; it seems likely that its more forward position occurs in examples with an unusually short snout.

The fin itself is variable in size and shape. In South Australian examples examined in the flesh the following variation occurs:

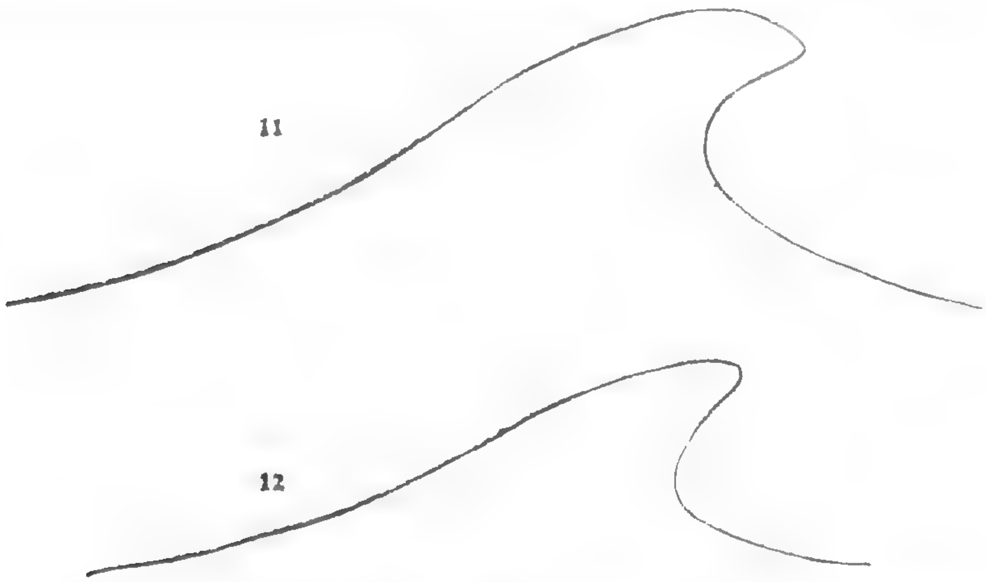

Fig. 11-12. Dorsal fins of adult male, Glenelg (11) and (12) of aged female, Encounter Bay (1/5 nat. size).

Specimen and body length.	Length of fin per cent body length.	Height of fin per cent body length.	Height per cent length of fin.
M.5009. ♀ 2,897 mm.	11.1	3.1	28.2
M.5010. ♀ 1,710 mm.	10.8	3.7	34.0
M.6186. ♂ 1,930 mm.	11.4	8.0	74.0
M.6256. ♀ 2,980 mm.	13.3	3.6	27.5
M.6266. ♂ 2,730 mm.	18.6	5.5	29.8

For comparison the proportions of examples from widely separated North Atlantic localities are given below, viz., Virginia and Massachusetts, U.S.A. (Glover Allen, 1941) and Japan (Yamada, 1954). These are taken from the measurements published by the aforementioned authors and indicate that the dorsal fin is surprisingly small in the Massachusetts adult male, whereas it is unusually high in a South Australian young male (M.6186).

Specimen and body length.	Length of fin per cent body length.	Height of fin per cent body length.	Height per cent length of fin.
Virginia; ♀, 2,210 mm. ..	11.7	6.5	55.7
Mass.; ♂, 3,200 mm. ..	4.3	2.3	54.2
Japan; ♀, 2,180 mm. ..	13.7	6.6	48.3
Japan; ♀, 2,220 mm. ..	15.3	5.8	38.2

Glover Allen (1941, p. 29), comparing some external characters of the one adult male and one breeding female, from the abovementioned separate localities off the Atlantic coast of the United States, remarks that "Apart from the generally greater dimensions of the adult male as compared with the adult female, the only striking difference is in the very much smaller dorsal fin, which in the male is low and narrow, while in the female it is of nearly twice the size (fig. 2) . . . Whether or not this is a normal sexual difference, or merely individual variation, future observations may show".

In the South Australian adult male (M.6266), 2,730 mm. in body length, the dorsal fin is of practically the same shape and proportions as that of the aged female (M.6256), 2,980 mm. in length; the male, however, has a relatively larger and higher fin (see fig. 11-12 herein).

Gunther, Hubbs and Beal (1955, pp. 263 and 266) writing of *Kogia* on the Atlantic coast of America, and recording an example from Texas, state that in the case of a specimen recorded from New Jersey by Enders (1942, fig. 2) "The length of the dorsal fin and its vertical height are much the smallest in the New Jersey specimen." In the opinion of these authors "The most unexpected and significant differences seem to be the measurements of snout to eye, snout to blowhole, and snout to dorsal fin. The last measurement is checked by the measurement from the fluke notch to the posterior insertion of the dorsal. These measurements and a comparison of the photographs indicate, with little doubt, that the dorsal fin of the Texas specimen was placed considerably further back than on the other two" (California and New Jersey).

It seems apparent that in so far as either sex or locality are concerned, the proportions of the dorsal fin have no significance. Yamada, however, writes "I liked to know what was known at sea, especially if they [examples of *Kogia*] belonged to the same school or were separated." Yamada was given some information by a whaler hunting in Japanese waters; this individual testified "that No. 5 was with No. 4 in a school of six or seven whales, and No. 6 in another of two or three. This may somewhat favour on one hand the opinion to recognize *K. simus* and seems on the other to be a new knowledge of the habits of kogiids". (Yamada, 1954, pp. 51-52; see also note by Palmer, Journ. Mamm., 29, 1948, p. 421.)

As already stated it is recognized that far too few accurate illustrations of the exterior of *Kogia* are available. Nevertheless, Glover Allen's adult female (1941, pp. 28-29, fig. 2) and a young male recorded by me (Hale, 1959, p. 335, fig. 1) have the dorsal fin high, with its origin in advance of the middle of the body length.

W. Elliot's drawings of a female from India (*simus* of Owen, 1869, pl. 10-11) are of doubtful accuracy but show a similar dorsal fin, as also does the illustration of Fraser and Parker (1949, p. 18, fig. 15) which may be a modification by the artist, Col. Simon, of the figures published by Owen.

While, as mentioned by some other authors, examinations of the variable skeletal characters gives one no reason to recognize more than one species of the genus (see for example Hirasaka, 1937, pp. 120, 135, 139, and Allen, 1941, p. 17), one may venture to support Yamada's indication that the animal occurs in semi-isolated migrating small herds. Further, to suggest that individuals of such schools may be separable from those of other herds by superficial external characters (including colouration), although much evidence is required to substantiate this theory. Comparison of cows and their calves could be useful. For example, in both the cow and female calf from Port Victoria (M.5009-5010) the dorsal fin is relatively small, and originates just behind the middle of the length of the body (cf. Glover Allen, 1941, and Hale, 1959, illustrating individuals with higher fins). The photographs of a male from California (Hubbs, 1951, pl. ii and iii) show a small dorsal fin, very like that of the Port Victoria cow and calf.

Colouration. From examination of the few Pigmy Sperm Whales stranded on South Australian coasts it is obvious that the extent of the darker portions, in relation to the white of the underside, shows considerable variation. The pigmented areas vary in colour also from blue, blue on the sides merging into brownish grey dorsally, dark grey and light bluish-grey.

Yamada (1954, p. 40, fig. 5) illustrates a bracket-like marking which occurs behind the eye in some specimens and, following Hubbs (1951, p. 408, pl. iii), suggests that this could be a generic character of *Kogia*. Hubbs' published photographs of a specimen taken near Imperial Beach, California, show the bracket very clearly. Gunther, Hubbs and Beal (1955, p. 267) comment on the presence or absence and variability of the marking. (See also note by D. K. Caldwell, Journ. Mamm., 41, 1960, p. 137.) This bracket was especially looked for in examples stranded on our coast during 1958 and 1959 but was not present, although there is possibly a faint indication of it in an unrecovered calf (Hale, 1959, p. 334, pl. XL) known only from photographs in colour. In the upper figure of the abovementioned plate there appears, very obscurely, an extension of the white ventral colour into the darker area behind the eye[6].

The colouration given for a female and calf from Port Victoria (Hale, 1947, p. 532), namely "jet black above and on the sides, fading into the white of the underside from back of the mouth to a little posterior to the anus" must now be ignored as being due to post-mortem change in the darker areas (Hale, 1959, p. 337).

It is certain that post-mortem changes in colouration can and do occur very rapidly in stranded examples, particularly when they are subject to heat or sunlight. Thus, from available evidence, specimens cast ashore do not necessarily provide a true indication of the life colouration, even though they may have died on the beach shortly before examination. However, reasonably fresh examples do show the colour pattern, viz., the distribution of the dark areas in relation to the white.

Skeleton

Skull. Attempts have been made to separate *Kogia* into species by utilizing skeletal characters.

Below are given some measurements of seven skulls of examples taken on South Australian coasts. Three of calves, 1,700 mm. to 1,892 mm. in body length, which were accompanying their mothers; one of a young male 1,930 mm. in length; three from adults 2,730 mm. to 2,980 mm. in length. These include for comparison the skull measurements of a female and her suckling calf previously recorded (Hale, 1947, p. 536).

The measurements, amplifying data supplied by other workers, show that marked variation occurs.

Skull measurements of adults, 2,730-2,980 mm. in length.

Measurements.	♀, M.5009. mm.	per cent.	♀, M.6256. mm.	per cent.	♂, M.6266. mm.	per cent.
Total (condylobasal) length	410	100	412	100	420	100
Height to vertex	245	59.7	266	64.5	245	58.3
Width between postorbital processes	360	87.8	360	87.3	355	84.5
Hinder edge of occipital condyles to posterior wall of left naris	150	36.5	154	37.3	150	35.7
Height of supraoccipital from upper margin of foramen magnum	115	28.0	133	32.2	122	29.0

(6) During September, 1961, while the present paper was in press, a young female came ashore in St. Vincent Gulf, S. Aust. This had a well defined bracket, comparable to that illustrated by Hubbs and which still could be traced 48 hours after the death of the animal.

Skull measurements of adults, 2,730-2,980 mm. in length—*continued.*

Measurements.	♀, M.5009. mm.	per cent.	♀, M.6256. mm.	per cent.	♂, M.6266. mm.	per cent.
Width of supraoccipital at narrowest part between posterior margins of temporal fossae	214	52.2	224	54.3	230	54.7
Length of rostrum from tip to anterior wall of left naris	227	55.3	239	58.0	225	53.5
Tip of rostrum to anterior margin of palatines	170	41.4	174	42.2	170	40.4
Width of rostrum between antorbital processes	220	53.6	218	52.9	194	46.2
Greatest length of pterygoids	188	45.8	208	50.4	180	42.8
Length of left naris	47	11.4	46	11.1	48	11.4
Width of left naris	33	8.0	35	8.5	34	8.0
Height of foramen magnum	42	10.2	38	9.2	40	9.5
Width of foramen magnum	41	10.0	36	8.7	32	7.6
Height of occipital condyles	64	15.6	64	15.5	68	16.2
Width of occipital condyles	90	21.9	88	21.3	81	19.2
Length of mandible (mid-line between tip and level of back of condyles)	360	87.8	375	91.0	350	83.3
Length of left ramus of mandible (condyle to anterior end)	380	92.6	405	98.3	382	90.9
Depth of left ramus at coronoid	100	24.3	90	21.8	90	21.4
Length of symphysis	80	19.5	110	26.7	95	22.6
Length of alveolar portion	140	34.1	190	46.1	170	40.4

Skull measurements of calves, 1,700-1,892 mm. in length (Port Victoria, Sleaford Bay and Encounter Bay).

Measurements.	♀, M.5010. mm.	per cent.	Sex? M.6156. mm.	per cent.	♂, M.6257. mm.	per cent.
Total (condylobasal) length	250	100.0	265	100.0	295	100.0
Height to vertex	150	60.0	180	67.9	186	63.0
Width between postorbital processes	210	84.0	240	90.5	262	88.8
Hinder edge of occipital condyles to posterior wall of left naris	124	49.6	134	50.5	130	44.0
Height of supraoccipital from upper margin of foramen magnum	80	32.0	94	35.4	93	31.5
Width of supraoccipital at narrowest part between posterior margins of temporal fossae	155	62.0	170	64.1	166	56.2
Length of rostrum from tip to anterior wall of left naris	93	37.2	124	46.7	144	48.8
Tip of rostrum to anterior margin of palatines	76	30.4	93	35.0	119	40.3
Width of rostrum between antorbital processes	127	50.8	130	49.0	159	53.9
Greatest length of pterygoids	97	38.8	115	43.4	139	47.1
Length of left naris	33	13.2	30	11.3	35	11.8
Width of left naris	23	9.2	26	9.8	29	9.8
Height of foramen magnum	42	16.8	38	14.3	38	12.8
Width of foramen magnum	34	13.6	31	11.7	27	9.1
Height of occipital condyles	58	23.2	60	22.6	57	19.3
Width of occipital condyles	64	25.6	67	25.2	70	23.7
Length of mandible (mid-line between tip and level of back of condyles)	—	—	—	—	230	77.9
Length of left ramus of mandible (condyle to anterior end)	—	—	—	—	260	88.1
Depth of left ramus at coronoid	—	—	—	—	70	23.7
Length of symphysis	48	19.2	—	—	50	16.9
Length of alveolar portion	83	33.2	—	—	100	33.9

Skull measurements of young male (M.6186), 1,930 mm. in length, from Largs Bay.

Measurements.	mm.	per cent.
Total (condylobasal) length	243	100.0
Height to vertex	163	67.0
Width between postorbital processes	222	91.3
Hinder edge of occipital condyles to posterior wall of left naris	115	47.2
Height of supraoccipital from upper margin of foramen magnum	95	39.0
Width of supraoccipital at narrowest part between posterior margins of temporal fossae	162	66.6
Length of rostrum from tip to anterior wall of left naris	98	40.3
Tip of rostrum to anterior margin of palatines	77	31.6
Width of rostrum between antorbital processes	122	50.2
Greatest length of pterygoids	140	57.6
Length of left naris	32	13.1
Width of left naris	19	7.8
Height of foramen magnum	28	11.5
Width of foramen magnum	28	11.5
Height of occipital condyles	53	21.8
Width of occipital condyles	71	29.2
Length of mandible (mid-line between tip and level of back of condyles)	187	76.9
Length of left ramus of mandible (condyle to anterior end)	200	82.3
Depth of left ramus at coronoid	63	25.9
Length of symphysis	14	5.7
Length of alveolar portion	72	29.6

The above measurements indicate that with age the rostrum increases in length in relation to the length of the skull; further, in the four smaller examples (1,710-1,930 mm. in body length) it is wider than long, whereas in the three adults (2,730-2,980 mm. in body length) it is longer than wide.

It is now possible to compare the skulls of two breeding females with those of their suckling calves (pl. 1-2, A and B); these are from Port Victoria, Spencer Gulf (M.5009-5010, April, 1937) and Encounter Bay on the south coast (M.6256-6257, June, 1959). The skulls of the calves show no detail of import linking them with those of their mothers. It may be noted, however, that in both cow and calf from Encounter Bay the height to vertex is lower, and the pterygoids shorter, than in the female and young from Port Victoria. The occipital condyles in both calves resemble those of their respective mothers, but are similar also to those of some other individuals; in the calf of female M.6256 the foramen magnum is more ovate than in the parent.

Posterior views of the eight skulls available from South Australia are shown on pl. 1 and 2 herein; these comprise four adults and four juveniles, and serve to illustrate in part the descriptions of the skulls, including the occipital condyles and foramen magnum. The photographs are all to the same scale and, with exception of female M.5009 (in which the lower jaw bones are wired to the skull) are shown with the lower edge of the pterygoids and the tip of the rostrum resting in the same plane.

Vertebrae. From the descriptions of skeletons of *Kogia* I fail to find anything to correlate convincingly the varying lengths of the dorsal spines and other characters of the vertebrae with skull differences. The fusion of the epiphyses, however, is of interest.

Glover Allen (1941, p. 24) describing a female 2,210 mm. in body length (pregnant and taken with suckling calf), states that it "was fully adult, as indicated by the well-ossified mesethmoid and complete union of all epiphyses". The degree of fusion of the epiphyses of the vertebrae certainly seems to furnish some indication of age, as demonstrated in six of the examples stranded in South Australia; it would appear from this and other skeletal characters (*i.e.*, in the tongue bones, the thyrohyals and basihyal are fused) that the female from Encounter Bay (M.6256) is the oldest of the specimens. Details of the fusion of the vertebral epiphyses are given below. It will be noted that these fusions follow no completely uniform sequence (cf. M.6266 and M.5009).

M.5010, *female calf of* M.5009, 1,710 *mm. in body length.*

Cervical, 7; thoracic, 13; lumbar, 10; caudal, 23. Epiphyses of the centra are completely free on the following. Cervical: no. 7 only, posterior. All thoracics, anterior and posterior. All lumbars, anterior and posterior. Caudal: 1 to 19, anterior and posterior; because of their tiny size and extreme fragility it is impossible, after maceration, to ascertain whether or not free epiphyses were present in the last four caudals.

M.6257, *male calf of* M.6256, 1,892 *mm. in body length.*

Cervical, 7; thoracic, 14; lumbar, 9; caudal, 24. Epiphyses of the centra are completely free on the following. Cervical: posterior of centrum 6; both anterior and posterior of centrum 7. All thoracics, both anterior and posterior. All lumbars, both anterior and posterior. All caudals with exception of 7, which has the epiphysis attached to, but not completely fused with, the anterior face of the centrum.

M.6186, *calf from Largs Bay,* 1,930 *mm. in body length.*

Cervical, 7; thoracic, 14; lumbar, 10; caudal, 26. Epiphyses of posterior of cervical 7, and all remaining vertebrae both front and back, completely free.

M.6266, *adult male from Glenelg, 2,730 mm. in body length.*

Cervical, 7; thoracic, 12; lumbar, 9; caudal, 25. Epiphyses of the centra are completely free on the following. Thoracic: 2 and 3, anterior only; 4 to 12 both anterior and posterior. Lumbar: 1 to 3 both anterior and posterior; 4, 10 and 11 posterior only. Caudal: 5, 6, 8 and 13, both anterior and posterior; 12 anterior only. Epiphyses fused on all other faces of centra.

M.5009, *female from Port Victoria, 2,897 mm. in body length; pregnant and with suckling calf.*

Cervical, 7; thoracic, 13; lumbar, 9; caudal, 26. Epiphyses of the centra are completely free on the following. Thoracic: 3 to 13, both anterior and posterior. All lumbars, anterior and posterior. Caudal: 1, anterior and posterior; 2, anterior only; 3, posterior only.

In the first and second thoracics the epiphyses are almost completely fused with the centrum; from the sixth caudal back the edges of the epiphyses are barely or not at all distinguishable from the centrum.

M.6256, *adult female (with suckling calf) from Encounter Bay, 2,980 mm. in body length.*

Cervical, 7; thoracic, 13; lumbar, 9; caudal, 23. All epiphyses are completely fused with the centra.

Sternum. As in examples of *Kogia* from other localities the sternum of specimens taken in South Australia exhibit considerable differences (pl. 4). In one case, that of the young male from Largs Bay (pl. 4, A), it is composed of four segments, instead of the usual three, and these are all entire; as noted herein the skull of this calf is also unusual.

The degree of development of the anterior median notch of the manubrium has no significance, nor has the degree of fusion of the two components of each section. In this last respect the sternum of the large male from Glenelg (pl. 4, C) is interesting in that while the last, or third, stenebra consisted of two separate elements, that on the right side is completely ossified, the other cartilaginous but denser than, and readily distinguishable from, the surrounding cartilage.

Glover Allen (1941, p. 32) considers that "Very likely, as commonly in cetaceans, this wide variation in form of the sternum is a mark of degeneration in the structure".

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EXPLANATIONS OF PLATES

PLATE 1. POSTERIOR VIEWS OF SKULLS.

A and B, adult female, M.5009, body length 2,897 mm., and her female calf, M.5010, body length 1,710 mm.; C, sex unknown, M.5197, body length unknown; D, calf, sex unknown, M.6156, body length unknown. (All to same scale.)

PLATE 2. POSTERIOR VIEWS OF SKULLS.

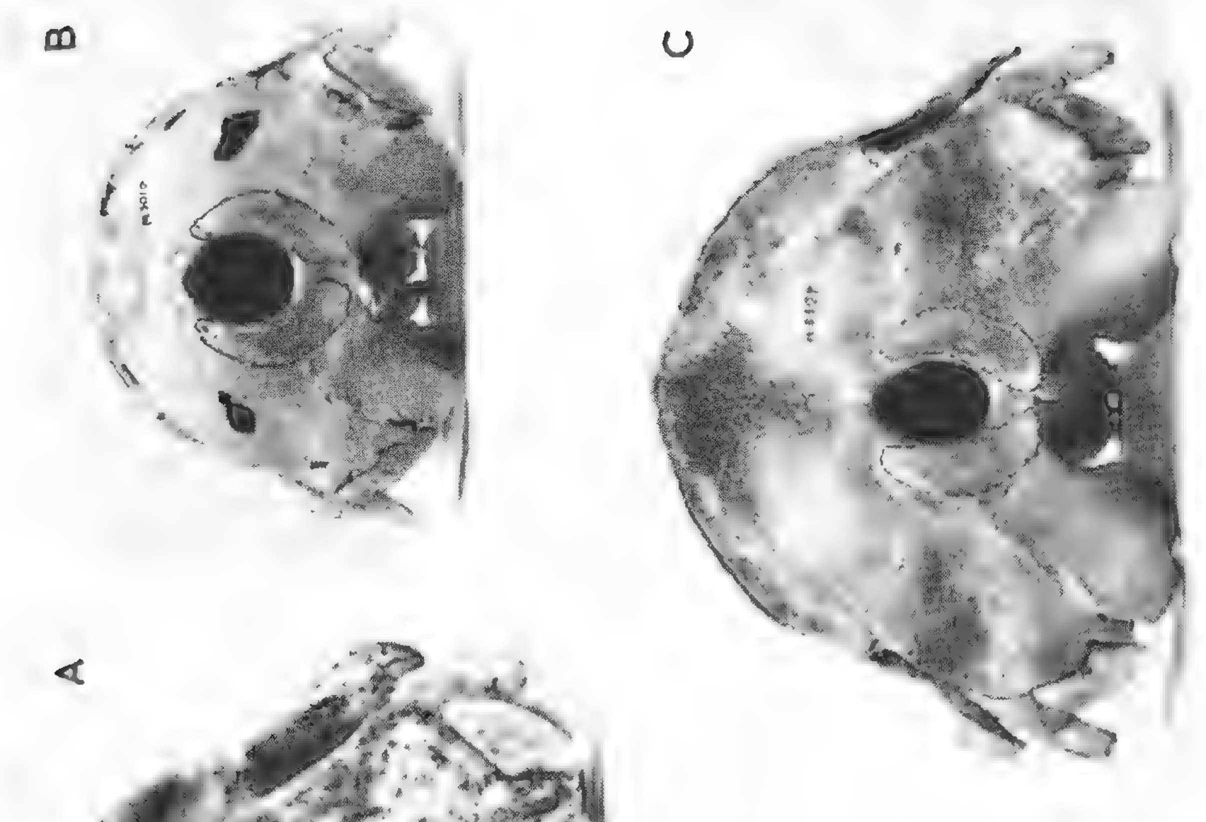
A and B, aged female, M.6256, body length 2,980 mm., and her female calf, M.6257, body length 1,892 mm.; C, young male, M.6186, body length 1,930 mm.; D, adult male, M.6266, body length 2,730 mm. (All to same scale.)

PLATE 3. TONGUE BONES.

A, young male, M.6186, body length 1,930 mm.; B, aged female, M.6256, body length 2,980 mm.; C, adult male, M.6266, body length 2,720 mm. (Not to same scale.)

PLATE 4. VENTRAL VIEWS OF STERNA.

A, young male, M.6186, body length 1,930 mm.; B, aged female, M.6256, body length 2,980 mm.; C, adult male, M.6266, body length 2,730 mm. (Not to same scale.)



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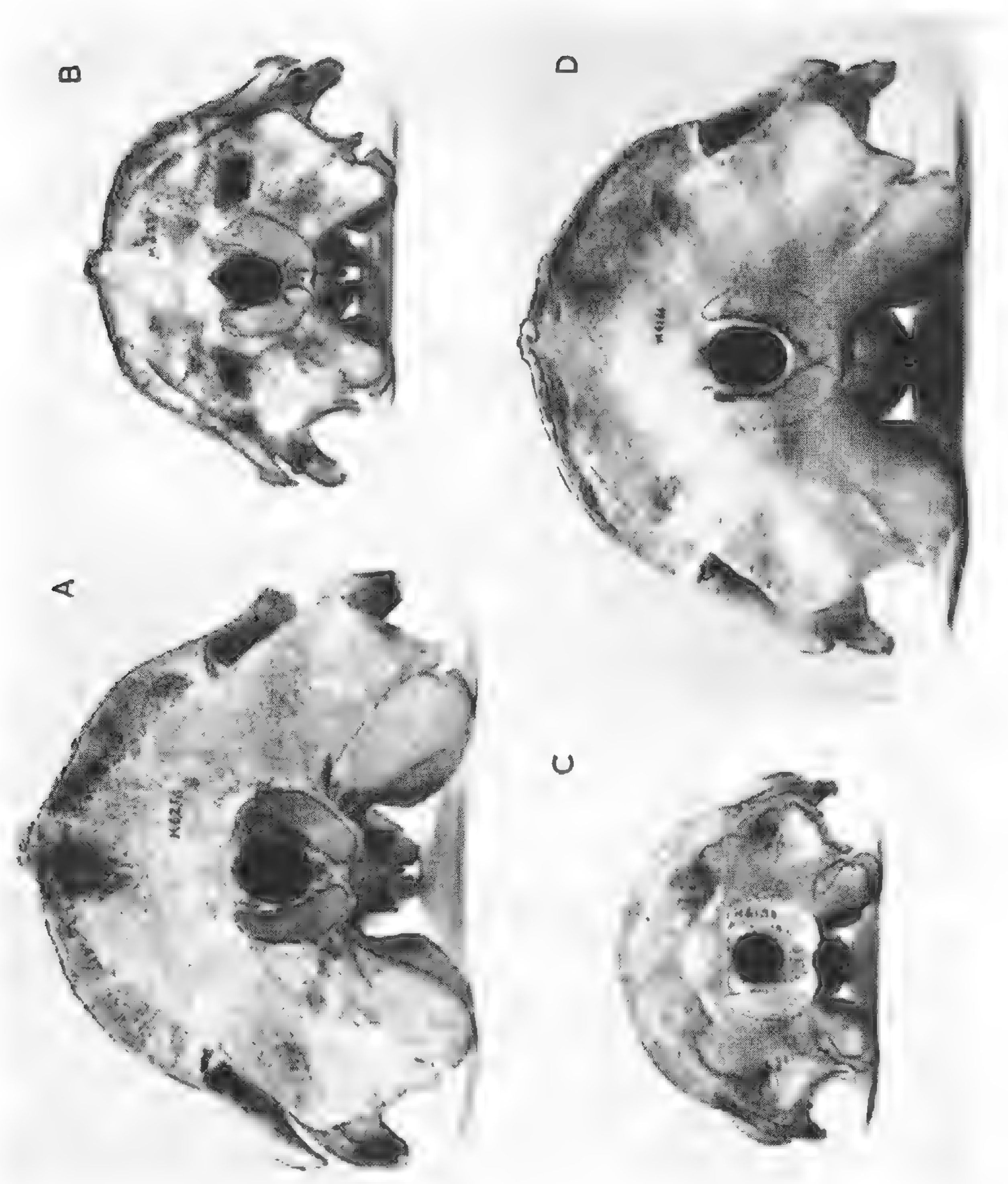
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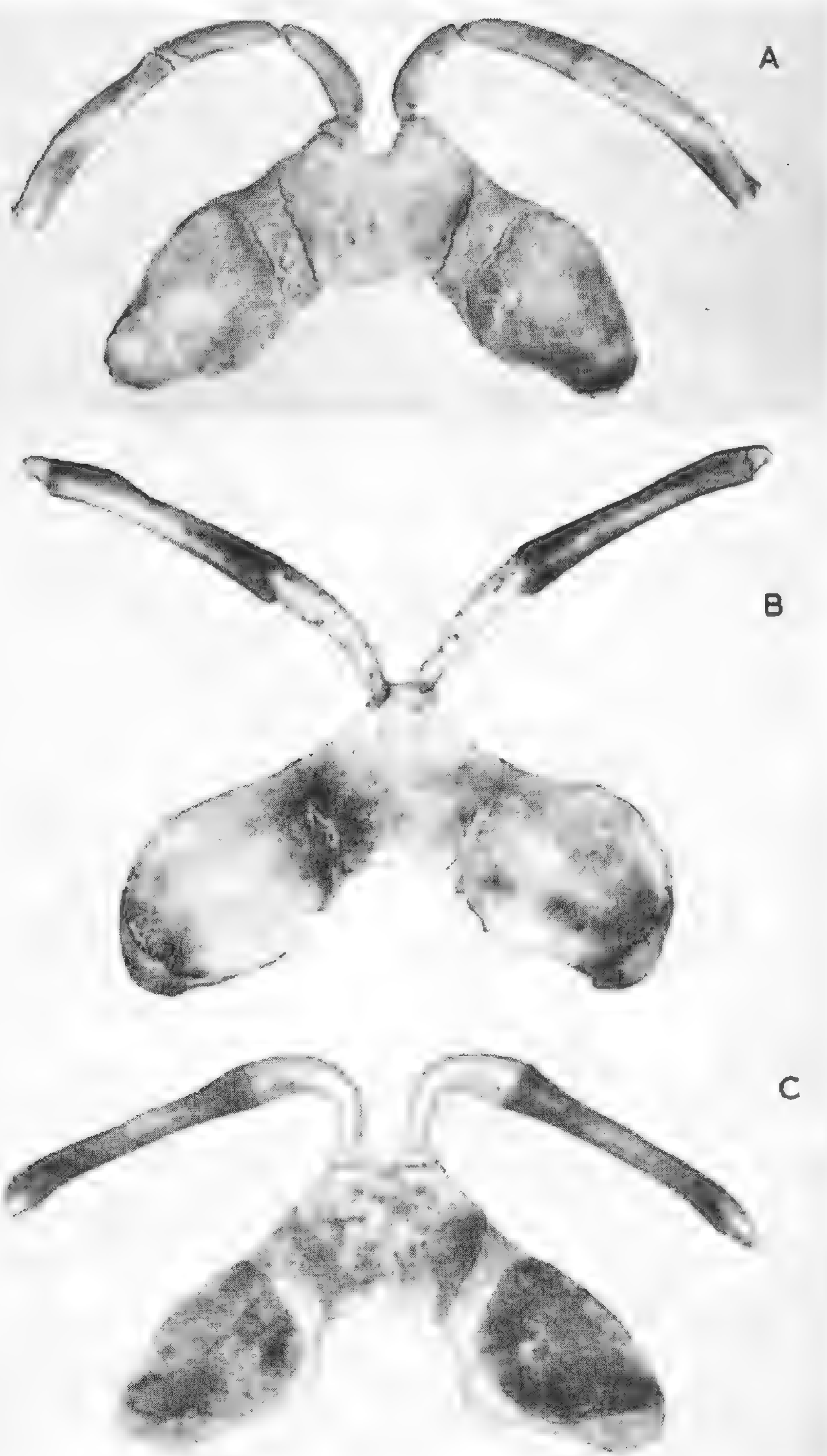
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OCCURRENCE OF THE WHALE BERARDIUS ARNUXI IN SOUTHERN AUSTRALIA

BY HERBERT M. HALE, HON. ASSOCIATE, SOUTH AUSTRALIAN MUSEUM

Summary

An adult female of the Beaked Whale Berardius arnuxi Duvernoy, stranded on a South Australian coast, is described herein. The relationship of the second species of the genus, B. bairdi Stejneger, is discussed.

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Loc: Port Lorne in St. Vincent Gulf, South Australia (skull and part skeleton in South Australian Museum; Reg. No. M.5012).

OCCURRENCE OF THE WHALE BERARDIUS ARNUXI IN SOUTHERN AUSTRALIA

By HERBERT M. HALE, Hon. Associate, South Australian Museum

Plates 5-6, and text fig. 1

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INTRODUCTION

A brief note recording the occurrence of *Berardius arnuxi* in South Australian waters was published previously (Hale, 1939, pp. 5-6, fig.).

The specimen, a pregnant female, was stranded in December, 1935, on an extensive tidal flat, south of Port Lorne, near the northern end of St. Vincent Gulf. The presence of the whale was not reported to me until early in January, 1936, and, in company with Messrs. J. and A. Rau and an assistant, the carcass was examined on January 6, when some flesh measurements and skeletal details were secured. The whale then had been carried by the tide to one mile north of Port Lorne, and was resting on the flat nearer to high tide level than when first seen by others. On the same day fleshing was partly carried out but as darkness fell work was interrupted by the invasion of the incoming tide which, as usual in this locality, raced across the flat with surprising speed and force, on this occasion coinciding with a sudden thunderstorm. The partly fleshed carcass was then anchored, securely as we thought, to strong stakes, but on visiting the site early next day we found that during a further storm in the night tidal action had gouged out a crater where the whale had been lying and that sections of the body were scattered about the flat. With the aid of a local fisherman all but the major part of the caudal vertebral section, comprising caudals four to nineteen, were recovered. Despite extensive search by the Museum party, and later, following offer of a substantial reward, by residents adjacent to Port Lorne, this portion, regrettably, was never recovered.

External Characters

Mr. J. J. Waters, of Yatala, South Australia, observed, from a small boat, the whale when it was first stranded on December 27, 1935. He supplied, *in litt.*, the following information. "At the time when I saw it first it was at low water; the whale was then about half a mile from low water mark . . . When the tide rose sufficiently for us to go in we went to within twenty yards of it and were going to anchor it. After a time we discovered that it was alive. The only noise that it made was when it expelled air, a loud 'whish'; it was also moving its head from side to side. The colour on close inspection was black. Where it was when I saw it was due west from a big sand bank about two miles south of Port Lorne".

My best thanks are due to the abovementioned for their personal observations and I am indebted to Mr. C. P. Mountford for photographing the bones herein illustrated.

Table 1. Body proportions.

Measurements.	mm.	Per cent of length.
Total length to median projection of tail flukes	8,845	100.0
Tip of snout to anterior ends of throat grooves	381	4.3
Tip of snout to vertical level of anterior corner of eye	915	10.3
Tip of snout to blow hole	1,040	11.7
Tip of mandible to vertical level of anterior corner of eye	864	9.7
Projection of lower jaw beyond tip of snout	51	0.5
Tip of snout to vertical level of anterior end of base of dorsal fin	5,871	66.3
Tip of snout to axilla	1,982	22.4
Width of flukes	2,238	25.3
Height of dorsal fin	153	1.7
Length of base of dorsal fin	534	6.0
Length of pectoral fin, axilla to tip	787	8.9
Greatest width of pectoral fin	432	4.8
Length of eye	38	0.4
Depth of eye	16	0.1

Skeleton

Skull (pl. 5, fig. A-B). This is a little less than one-seventh of the body length. It is of the same size as the type skull of Duvernoy and in general differs in no very significant detail from the descriptions of other authors. The mesethmoid, however, rises above the level of the premaxillae (cf. Flower, 1874, p. 218, pl. 28, fig. 8) while its rugose ossification extends to approximately 320 mm. in front of the base of the rostrum, as measured between the posterior limits of the antorbital notches, a feature due to the greater age of the Australian female.

Measurements of the skull, mandibles and teeth are given in tables 2 and 3.

Table 2. Skull measurements.

Measurements.	mm.	Per cent of length.
Total (condylobasal) length	1,260	100.0
Height from vertex to inferior border of pterygoids	648	51.4
Breadth across postorbital processes	700	55.5
Length of rostrum	765	60.7
Breadth of rostrum at base	435	34.5
Breadth of rostrum at middle	168	13.3
Length of premaxilla	1,085	86.1
Breadth of premaxillae at middle of length	122	9.6
Greatest breadth of premaxillae in front of nares	218	17.3
Greatest breadth of premaxillae behind nares	200	15.8
Distance from anterior end of premaxillae to level of posterior borders of pterygoids	995	78.9
Length of nares (greatest median)	120	9.5
Breadth of nares (greatest)	98	7.7
Breadth across occipital condyles	220	17.4
Breadth of right condyle	95	7.5
Height of right condyle	154	12.2
Length of mandible (right)	1,155	91.6
Length of symphysis	290	23.0
Height at coronoid	230	18.2
Distance from tip of jaw to centre of 1st tooth	50	3.9
Distance from tip of jaw to centre of 2nd tooth	150	11.9
Height of 1st tooth: right	104	8.2
left	105	8.3
Greatest length of 1st tooth: right	65	5.1
left	70	5.5

Hyoids. The basihyal has the median anterior incision much deeper, and the adjoining prominences more elevated, than in the younger specimen described by Flower (1874, p. 223, pl. 28, fig. 9; body length about the same as that of the Australian female); this bone is two and one-quarter times as wide as its median length, and is more massive than as described by Flower, its breadth being 180 mm. The thyrohyals are not fused to the basihyal and like the stylohyals are also more massive, not much longer, but relatively distinctly wider.

Vertebrae (pl. 6, fig. B-H). Cervical, 7; thoracic, 11; lumbar, 12; caudal, 19.

The vertebrae were counted in the partly fleshed animal but, as already mentioned, most of the caudals were lost during a storm.

There are in hand, however, all cervicals, thoracics and lumbars together with the first to third caudals and three pairs of chevrons, each of the latter with the components fused. The field notes also show that there are ten ribs on the left side and eleven on the right.

The epiphyses are all coalesced with the free ends of the centra, so completely incorporated that they have become an integral part of all of the latter.

In the first three fused cervicals the maximum height of the combined dorsal processes of the first and second is two-sevenths of the greatest depth of the mass, with the upper surface rising, not steeply, to the rear, where there is an irregular median incision between a pair of apical bosses. The atlas is decidedly wider than high. The neural arch of the third cervical is free on both sides for a short distance, above the third large lateral foramen, but is complete, although the dorsal apical portion is fused with, but below the level of, the dorsal part of the arch of the second vertebra. The fourth to seventh cervicals also have complete neural arches. In the fourth and fifth there is no dorsal process, the upper sides of the arch being almost uniform in anterior-posterior width, but sloping slightly upwards dorsally; the fourth is not higher than its greatest width. The sixth has a low, obtusely rounded dorsum and the seventh a short, triangular dorsal process, less than one-seventh of the total height of the vertebra, which thus is wider than high. The centrum of the seventh has a median gutter on the ventral surface, where in the preceding cervicals is a low protuberance.

The dorsal spines of all eleven thoracic vertebrae slope backwards and in general resemble those described and figured by Flower in 1874, although his example had only ten thoracics. The first is wider than high, because of the low dorsal process. The eighth has a pronounced lateral rib-attachment facet on each metapophysis and another articular facet on each side of the posterior end of the centrum. The ninth thoracic has the dorsal process fairly well developed and is nearly twice as high as its greatest width. Each of the prominent lateral processes first appearing on the tenth has a large and rugose articular face on the distal end.

The twelve lumbars differ in no essential feature from those described by Flower. The distal parts of the dorsal processes, however, are inclined towards the left in the first two, towards the right in the third to fifth, again to the left in the sixth and seventh, slightly to the right in the eighth to tenth and to the left in the eleventh. The first lumbar is wider than high and the dorsal process, as in the thoracics, is rather slender, the greatest width at the distal end being one-fourth of the length, the last measured from the upper limit of the neural arch to the apex. The dorsal process of the remaining lumbars is wider, but the increase in breadth is not successively regular until the ninth; in the eleventh the width of the distal end is not much less than half the length of the process and in the twelfth slightly more than half the length. The sixth lumbar has become much higher than wide.

The first to third caudal vertebrae have the distal end of the dorsal processes, as in the posterior lumbars, expanded and truncate, their apical width being more than half the length. The height of the first caudal is more than one-third as long again as its width.

Sternum (pl. 5, fig. C). The components of each of the five segments are solidly fused. The massive first segment has the whole anterior margin shallowly concave and the lateral articular processes more prominent than as shown in the illustrations of this structure in *arnuxi* (cf. Flower, 1874, pl. 27, fig. 3 and Morelli, 1920, pl. 4, fig. 4). The posterior processes of the last segment are shorter than depicted in the abovementioned illustrations.

Scapula (pl. 6, fig. 1). Resembles very closely the photographs of this bone by Morelli (1920, pl. 4, fig. 3, and pl. 5, fig. 2; adult female of *arnuxi* from La Plata).

Ribs. As already noted, there are ten ribs on the left side and eleven on the right. The eleventh has no trace of a fellow on the left and is much shorter than either of the tenth ribs. The tubercle is rudimentary in the ninth ribs, disappearing on the tenth pair and the single eleventh rib. The differences in the lengths of ribs of a pair, given below, are not significant, depending mainly on the projection of the distal rugosity.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	450	450
2	730	710
3	890	895
4	990	970
5	1,015	1,015
6	1,055	1,050
7	1,045	1,040
8	1,040	1,035
9	970	Broken tip
10	825	830
11	435	Absent

DISCUSSION

The two species of *Berardius* recognized in literature occupy, as far as is known at present, widely separated oceanic areas. The genotype, *B. arnuxi* Duvernoy, has been taken from the Antarctic Ocean to South America, New Zealand and southern Australia, while *B. bairdi* Stejneger occurs in the North Pacific, from the Bering Sea to California and Japan.

External Characters

Omura, Fujino and Kimura (1955, p. 99) furnish body proportions of four females of *bairdi* from Japan in percentages of total body length; the South Australian female is compared below with these and other specimens.

The snout was relatively longer, and the lower jaw projected for a lesser distance from the tip of the snout than in the Japanese females. Measurements of a young female, of the same total length as the South Australian specimen, are given by Pike (1953, p. 101); these show the projection of the lower jaw beyond the snout to be still less than in the Australian female.

The throat grooves were approximately 535 mm. in length, and as usual did not meet in front; posteriorly they were separated by a distance of 380 mm. As shown in Table 1 the eye was well in advance of the blowhole.

The dorsal fin, although approximately equal in length to those of the Japanese females, was considerably lower. This fin is high in some other females referred to *bairdi*; for instance see True, 1910, p. 67 and Pike, 1953, p. 101. True, *vide* Hector, indicates that the dorsal fin of the Wellington, New Zealand, male *arnuxi* is relatively still higher.

The pectoral fins were fully as long and wide as those of the Japanese females.

The caudal fin showed no trace of a median notch; on the contrary the rear edges of both flukes were concave, a little sinuate and met medianly to form a slight but distinct projection (fig. 1), the tip of which was only 77 mm. posterior to the last, and tiny, caudal vertebra. The flukes were not symmetrical, the left, measured from tip to the median projection, being 1,069 mm. in width, the right 1,169 mm. The total width of the caudal fin corresponds with the proportion to body length of a large adult female of *bairdi* from Alaska, as given by True (1910, p. 67) and while less than that of the abovementioned Japanese females, is greater than stated in the few available body measurements of *arnuxi*.

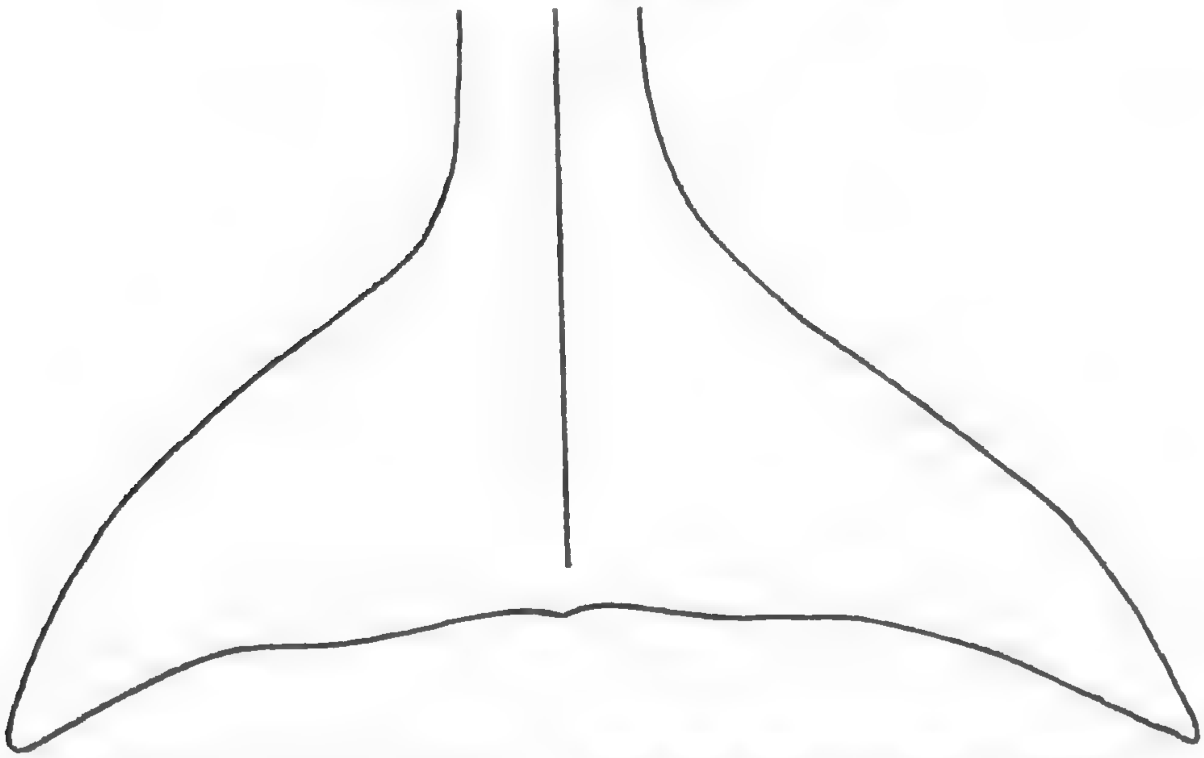

Fig. 1. Dorsal view of caudal fin of *Berardius arnuxi* from South Australia ($\frac{1}{18}$ nat. size).

It is possible that the posterior margins of the tail flukes of the South Australian *Berardius* had been damaged, and healed, during life, but it is difficult to imagine that in such case the width of the caudal fin could be increased, but if anything the reverse. Mutilation of the fins of living whales is by no means unusual (see for example R. M. Gilmore, Journ. Mamm., 42, 1961, pp. 419-420).

The distortion of the dorsal processes of the lumbar vertebrae suggest that the whale suffered a mishap at some period of its existence.

Skeleton

In Table 3 the skull measurements, per cent of breadth, of the South Australian female are compared with those of two females referred to *bairdi*. One, not fully adult and taken off the coast of Vancouver Island, British Columbia (Pike, 1953, p. 103) is equal in size to the South Australian example. The second, from the opposite side of the North Pacific, is a larger adult female (Omura, Fujino and Kimura, 1955, p. 109). The last column refers to a "physically adult" *Berardius*, thought to be a female, and not specifically identified, from near Ocean City, Washington (Slipp and Wilke, 1953, p. 108).

Table 3.

Measurements.	S. Aust. 29ft. adult.	Vancouver Is. 29ft. immature.	Japan. 36ft. adult.	Washington. 34ft. 5in. adult.
Total (condylobasal) length	180.0	203.8	196.8	181.8
Height from vertex to inferior border of pterygoids	92.5	79.7	79.1	73.6
Breadth across postorbital processes ..	100.0	100.0	100.0	100.0
Length of rostrum	109.2	132.0	127.6	116.7
Breadth of rostrum at base	65.0	60.2	60.5	56.3
Breadth of rostrum at middle	24.0	29.4	27.8	26.0
Length of premaxilla	155.0	180.9	191.1	162.6
Breadth of premaxilla at middle of length	17.4	20.9	15.7	15.7
Greatest breadth of premaxillae in front of nares	31.1	36.3	31.9	31.1
Greatest width of premaxillae behind nares	28.5	30.8	26.6	27.2
Distance from anterior end of premaxillae to level of posterior border of pterygoids	142.1	131.3	162.0	141.8
Length of nares (greatest median) ..	17.1	16.7	19.5	17.1
Breadth of nares (greatest)	14.0	19.0	15.9	16.6
Breadth across occipital condyles ..	31.4	32.8	33.0	27.9
Breadth of right condyle	13.5	15.2	15.1	13.9
Height of right condyle	22.0	26.3	22.6	21.6
Length of mandible (right)	165.0	180.6	180.1	—
Height at coronoid	32.8	32.2	32.4	28.2

The South Australian skull has the rostrum shorter and wider at the base than in the three North Pacific examples but otherwise exhibits no measurements of significance. The proportions of the rostrum, moreover, can hardly be regarded as important, for according to True's cited measurements of *arnuxi* in the New Zealand examples it is longer, and narrower basally, than in the Australian specimen, and falls within the range of *bairdi.* Remington Kellogg (in Slipp and Wilke, 1953, p. 109) writes "So far as can be judged from the five *bairdii* skulls in this Museum [U.S. National Museum], the breadth of the rostrum at the base . . . seems to vary considerably".

In short, the measurements of these and other skulls of *Berardius* support True's statement (1910, p. 69) concerning the skulls of the few specimens discussed by him "there appears to be nothing which can be fixed upon in this small series to distinguish the two species by dimensions alone".

As far as can be ascertained with the bones *in situ* the tympanics and periotics resemble those figured by True (1919, pl. 35. 37, fig. 7) for *bairdi* rather than Flower's illustrations of these bones in *arnuxi* from Canterbury, New Zealand.

The mandibles (pl. 6, fig. A) are relatively deeper than in the adult female from Japan referred to *bairdi,* and 36 feet in length

(Omura, Fujino and Kimura, pl. 9); also than in the female (?) of Slipp and Wilke (1953, p. 108), 34 feet in length, in which the depth at the coronoid is 222-223 mm., this measurement in the South Australian example being almost 5 per cent greater, notwithstanding the smaller size of the last named specimen. In Flower's description (1874, p. 221) of *arnuxi* from New Zealand, about 30 feet in length and yet "far from adult" the depth at the coronoid is given as only 8.3 inches, or about 205 mm.

When the carcass was first seen by me at Port Lorne the posterior of the two pairs of teeth were in place, slightly moveable in their sockets and with the tips projecting slightly above the gum. According to eyewitnesses the large anterior teeth also were loose in their sockets and approximately an inch of the apical portion of each was exposed and obvious, thus tempting a visitor forcibly to remove them. Fortunately, thanks to the prompt action of the district police officer, Constable Mahony, these teeth were recovered during the first day of our operations.

As indicated by the measurements, the anterior-posterior length of the front tooth of the right mandible is less than that of the left; the right tooth had been extracted with very little damage to the alveolus but the distal part of the left mandible is broken on the outer face although its tip is intact (pl. 6, fig. A). The large teeth, when fitted into their respective sockets, are forwardly inclined in the jaw, although less so than in the second pair; both anterior teeth have the root completely closed, thick and rugose.

In the immature *arnuxi* described by Flower (1874, p. 222) the pulp cavity in the first pair of teeth is completely closed below, while the tips, as in the South Australian female, show little or no sign of abrasion. These teeth in larger females (*bairdi*) from Japan, and 33-35 feet in length, show definite apical erosion (Omura, Fujino and Kimura, 1955, pl. 6, fig. 1-2) but those of an immature Japanese female of about the same length as the South Australian female, are much as in the latter.

Table 4 provides measurements, per cent of condylobasal length of skull, of some vertebrae and the scapula of two adult females of *Berardius*. Right column, *bairdi* from Japan, 36 feet in body length; skull 1,421 mm. in length (Omura, Fujino and Kimura, 1955, p. 111). Left column, *arnuxi* from South Australia, 29 feet in body length; skull 1,260 mm. in length. The incorporated epiphyses are included in the length of the centra of the vertebrae in the Australian specimen, as presumably they must have been in the adult Japanese female.

Table 4.

Measurements.	Per cent length of skull.	
Atlas:		
Breadth	19.4	22.9
Height	16.6	21.3
Fourth cervical:		
Greatest height	15.6	16.3
Greatest width	15.7	14.0
Length of centrum	2.3	2.6
Seventh cervical:		
Greatest height	17.8	16.8
Greatest width	19.3	13.2
Length of centrum	3.7	2.9
First thoracic:		
Greatest height	19.4	23.2
Greatest width	20.3	19.9
Length of centrum	4.6	4.4
Ninth thoracic:		
Greatest height	28.5	32.5
Greatest width	14.4	18.4
Length of centrum	12.0	11.8
First lumbar:		
Greatest height	36.1	38.4
Greatest width	38.0	38.4
Length of centrum	14.2	14.4
Sixth lumbar:		
Greatest height	42.0	46.5
Greatest width	36.1	38.4
Length of centrum	17.8	17.0
First caudal:		
Greatest height	47.2	51.1
Greatest width	34.9	36.2
Length of centrum	20.2	20.9
Length of scapula	40.8	44.8
Height of scapula	31.7	34.2

In the Australian female the skull is proportionally longer than in the larger Japanese female, 14.2 as against 12.9 per cent of body length. If the Australian skull were relatively as short as that of the Japanese female the ratios given for the vertebrae would be about one-tenth greater and thus in some approximately or quite equal to those for the Japanese specimen. Minor differences in the vertebrae probably represent only individual variation. It is known that the ratio of skull length to body length is variable in *Berardius*. True (1910, p. 67), relying on limited data, considered that *arnuxi* has a relatively larger skull than *bairdi*. On the other hand Omura, Fujino and Kimura (1955, p. 119) note that in *arnuxi* the posterior caudals are smaller than in *bairdi* (also True, 1910, p. 72). The abbreviation of the caudal region may be a constant character in *arnuxi* but here again examination of further southern examples is desirable.

From descriptions and figures it is evident that the sternum of *Berardius* is subject to considerable variation, particularly anteriorly and posteriorly. That of the South Australian specimen is composed of five thick bones, in the first of which the anterior border, as noted above is widely concave (pl. 5, fig. C).

The scapula of the Australian specimen is much more like that of *Hyperoodon planifrons* (see Hale, Rec. S. Aust. Mus., IV, 1931, fig. 18), and of the *Berardius arnuxi* illustrated by Morelli in 1920, than as shown in True's figure (1910, pl. 33, fig. 2) of this bone in *Berardius bairdi.*

CONCLUSION

With information recorded to date one cannot but accept with some reservation the premise that the caudal fin is constantly relatively wider, and the pectoral fin larger, in *bairdi* than in *arnuxi.* This was suggested by True (1910, p. 67) and supported by Pike (1953, pp. 100-102) as well as Omura, Fujino and Kimura (1955, pp. 106 and 119). If these constitute the only differences, the validity of *bairdi* as a true species would be questionable; the features of the South Australian female alone tends to raise a doubt (see Table 1 herein), although it would seem that *Berardius,* possibly because of a longer caudal region, attains a greater adult length in the North Pacific than it does in southern seas. Bearing in mind the great distance between the known distribution areas of *arnuxi* and *bairdi* it is reasonable to regard them as separate forms; future records of *Berardius* may throw further light on the status of the two living representatives of the genus.

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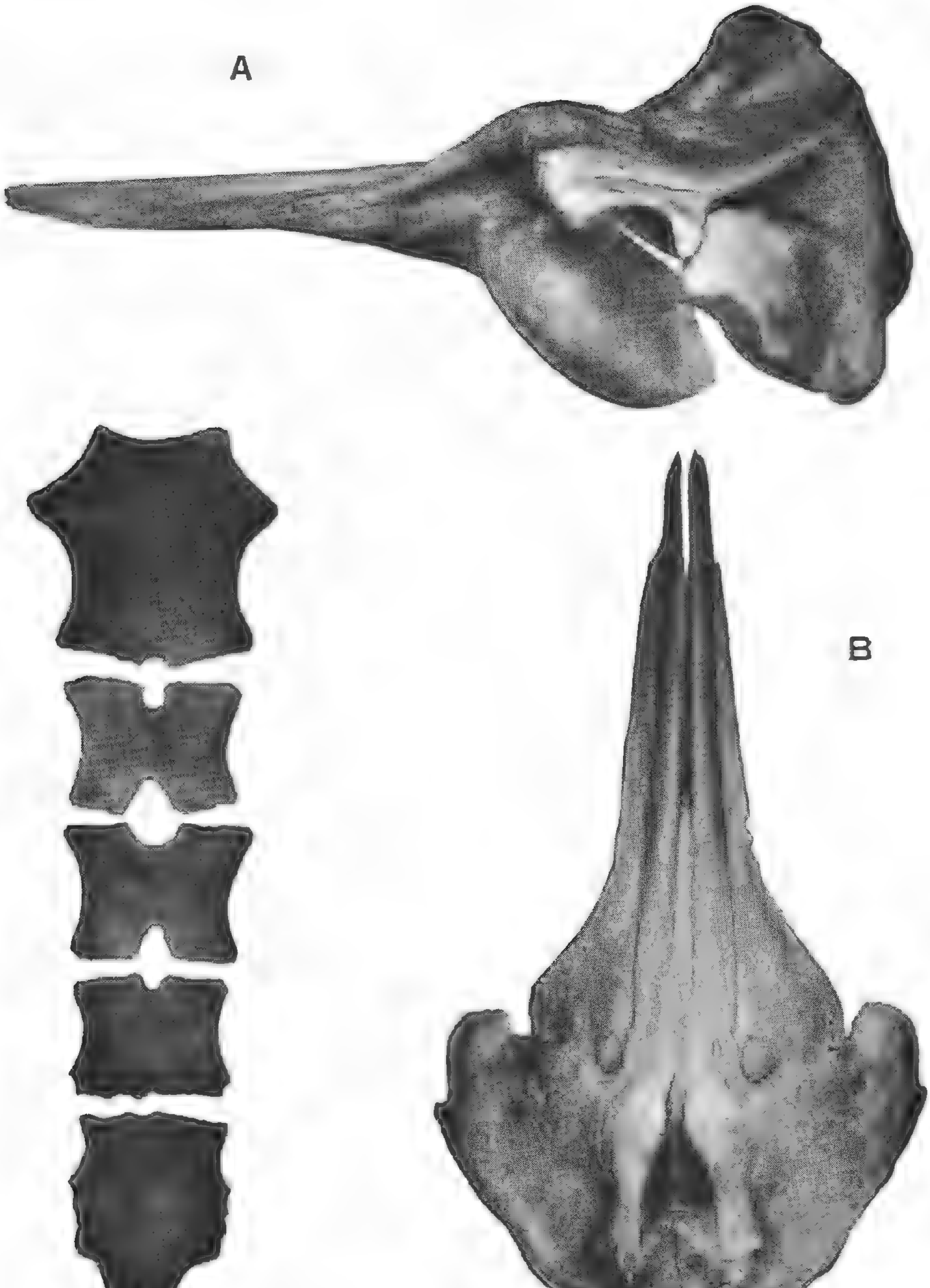
EXPLANATION OF PLATES 5 AND 6

PLATE 5.

Berardius arnuxi from South Australia. A and B, lateral and upper views of skull (1/10 nat. size). C, sternum (1/12 nat. size).

PLATE 6.

Berardius arnuxi from South Australia. A, mandibles. B to H, vertebrae; B, cervicals; C to F, first, eight, ninth and tenth thoracics; G, first lumbar; H, first caudal. I, scapula (all 1/6 nat. size).



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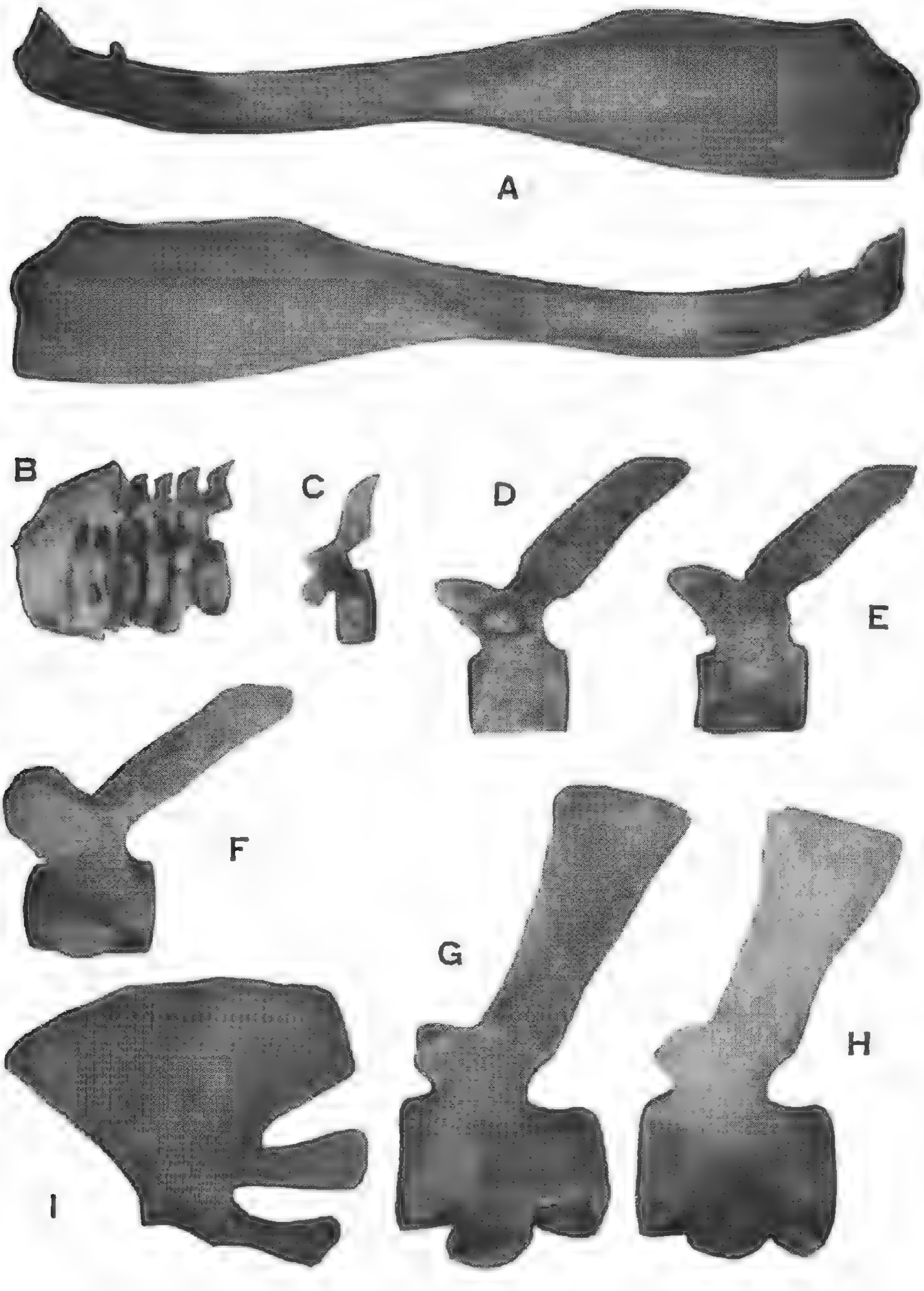
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ROCK ENGRAVINGS AT KOONAWARA, WESTERN NEW SOUTH WALES

BY CHARLES P. MOUNTFORD, HONORARY ASSOCIATE IN ETHNOLOGY,
SOUTH AUSTRALIAN MUSEUM

Summary

This paper records a number of rock engravings at Koonawara, north of Broken Hill in Western New South Wales. Many of these are forms which have not been previously described.
This record is due, in the first place to Mr. T. A. Brown, who, with others, has specialized in photographing, in colour, some of the outstanding rock engravings on sites adjacent to Broken Hill. Although most of these sites have already been recorded by Dow (1938, pp. 101-120), and Black (1943) in "Aboriginal Art Galleries of Western New South Wales" none of them have been studied in any detail.

ROCK ENGRAVINGS AT KOONAWARA, WESTERN NEW SOUTH WALES

By CHARLES P. MOUNTFORD, Honorary Associate in Ethnology, South Australian Museum

Fig. 1

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INTRODUCTION

Dow (1938, pp. 101-120) published a survey of the rock art of the aborigines who had lived in the somewhat arid country of western New South Wales. During 1943, Black published a well-illustrated booklet "Aboriginal Art Galleries of Western New South Wales" in which he lists, describes and illustrates engravings and cave paintings from nineteen localities known in western New South Wales at the time.

Recently, as mentioned earlier, Mr. T. A. Brown and others have specialized in photographing examples of rock engravings from those sites already recorded.

TECHNIQUES OF REPRODUCTION

The methods used for producing the illustrations on fig. 1 from Mr. Brown's colour photographs are:—The transparencies were placed in an enlarger and the designs, which were easily distinguished because of the excellence of the photographs, traced with pencil on a sheet of card.

The transparencies were then examined with a magnifying glass against a strong light, and corrections made on the pencil sketch until it was accurate. This sketch was then inked in and mounted. By this method, particularly if the transparencies are of a high quality, the final drawing would be as accurate as that obtained by any other method.

Description of Figure 1: A is a group of three designs, a large, well-executed dancing human figure with arms outstretched; a much smaller figure under the left arm, and a loop-like design which extends across the legs of the larger figure. B is a human figure, with legs turned inwards, who is wearing (probably) some ceremonial head-dress. C is a human figure with arms and legs outstretched. There is a circle with a dot in the centre between the outstretched legs. The human figure at D is wearing what appears to be a tall, and particularly elaborate head-dress. Black (1943, p. 100) and Dow (1938, fig. 15) both illustrate rock engravings at Euriowie which depict human figures wearing tall head-dresses. E is a complex, particularly well-executed maze-like design which bears more than a passing resemblance to cave paintings at Gundabooka (Black, 1943, p. 123), and at Wiltagoona (Black, 1943, pls. 130, 131, 134, 135). There is a line of bird tracks to the right of this design. F is a simple, but fully intagliated engraving of the tracks of an unidentified marsupial. The star-like design at G, bears some resemblance to a simple rock engraving at Ewaninga (Mountford, 1960, fig. 5). On the left of H is a single barred circle and to the right a line of bird tracks. The single barred circle, although normally rare in rock engravings, dominate a group in Mount Chambers Gorge in South Australia reported by Mountford (1928, pp. 347-349). J, P, and T are varying forms of the multiple-barred circle, designs which are also present in Panaramitee North (Mountford, 1929, p. 347-349). K is a pair of well-engraved human footprints; M, those of an emu seated on the ground, and N, those of an emu walking. L is a complex, but indecipherable design. O is a representation of an emu seated on a nest of eggs. The small black discs symbolize the eggs, while the footmarks of the seated emu are shown on either side of the nest. A portion of the rock (shaded portion) has split off the left-hand design. Spencer and Gillen (1899, No. 12, fig. 124) record a cave painting at Ayers Rock, which illustrates an emu sitting on a nest of eggs which resembles the engraving at O. Q and S are rock engravings of human figures wearing head-dresses.

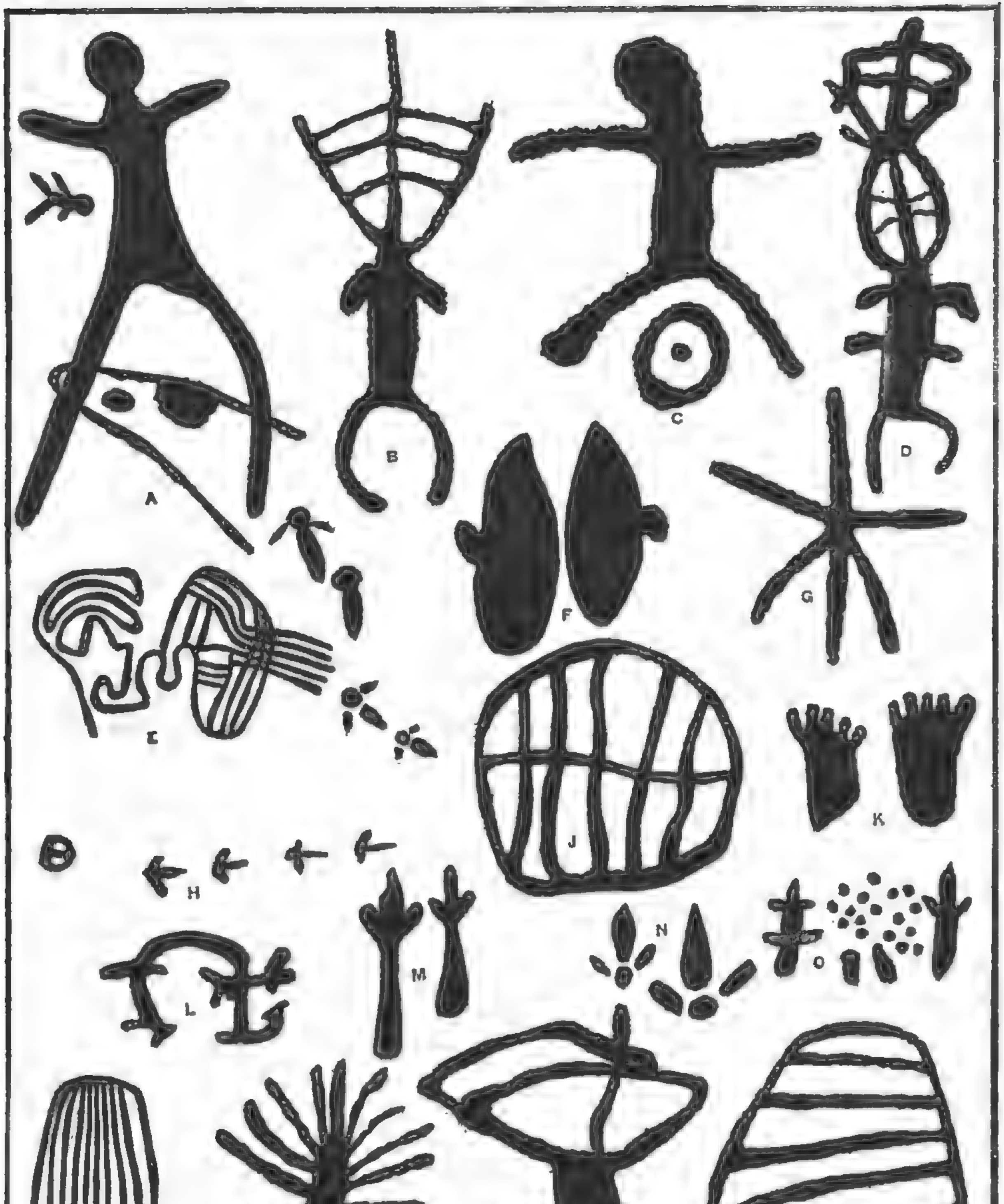

Fig. 1. Rock Engravings, Koonawara, Western New South Wales.

DISCUSSION

Dow (1938, p. 119), points out that the rock engravings of the Western Darling area depict a much wider range of designs and use a slightly higher degree of skill than those recorded from South Australia, which consist, in the main, of irregular circular figures, and scattered tracks of animals and birds.

This statement is undoubtedly true and somewhat puzzling, considering that distances separating the two localities is less than 200 miles, and the country and climate almost identical. Yet, except for three outstanding examples of engravings of marine creatures no longer living in the Panaramitee area, *i.e.*, the head of a sea-going crocodile, at Panaramitee North (Mountford, 1927, pp. 245-248, pl. 10, figs. 1-4); a marine turtle at Yunta (Mountford, 1928, fig. 87, p. 361), a recent unpublished find of a salt-water fish, I have not seen, among the many hundreds, probably thousands, of rock engravings I have examined in South and Central Australia, an engraving of an animal or of a human being.

At the present moment, there is no evidence to explain the reason for the wide difference in the designs, only future research will reveal the reason.

ACKNOWLEDGMENT

I am indebted to Mr. T. A. Brown for lending his colour transparencies from which I made the drawings on fig. 1.

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SOME TINGIDAE (HEMIPTERA) IN THE SOUTH AUSTRALIAN MUSEUM

By Carl J. Drake and Florence A. Ruhoff[1]

Summary

Through the kindness of Mr. G. F. Gross, Curator of Insects, South Australian Museum, Adelaide, we have received a small collection of undetermined Tingidae. This collection comprises 20 species, three of which are described as new to science. The types (holotype and allotype) and other specimens are deposited in the above Museum. The work was supported in part by the National Science Foundation Grant No. 18721.

Subfamily CANTACADERINAE Stål

Phatnoma uichancoi Drake, Northeast Papua, elevation 1,300-1,500 feet, Gonycentrum tindalei Hacker, South Australia (Myponga, in moss and lichens; Coorong, 25 February 1959, in moss; Waterfall Gully, February 1959, from Berlese funnel). G. socium Drake and Ruhoff (p1. 7, fig. 1), South Australia (Naracoorte Bog, February 1959).

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Allocader nesiotes, sp. nov.

Plate 7, fig. 2

Brachypterous form. Very large, broadly obovate, reddish-brown with costal areas, paranota, and collar mostly testaceous, head grayish-testaceous; body beneath flavous-brown. Legs brown with tibiae testaceous-brown. Length 9.00 mm.; width (base of pronotum) 1.10 mm., (widest part of elytra) 5.20 mm.

Head very long, greatly extended in front of eyes, surpassing apex of second antennal segment, armed with one pair of short, thick, blunt tubercles a little in front of vertex, deeply transversely furcated behind eyes; bucculae very long, areolate, surpassing apex of clypeus; antenniferous tubercles deeply excavated within, with apices slightly curved inward. Antenna with first two segments short, not attaining apex of clypeus, last two segments absent. Rostrum extremely long,

(1) Both of Smithsonian Institution, Washington, D.C.

reaching middle of fifth abdominal sternite. Eyes small, rounded, slightly tuberculate, the stalk very short and rounded.

Pronotum depressed, areolate, tricarinate; carinae ridgelike, percurrent, the lateral pair interrupted at calli; calli deep, each with large deep pit; collar very long, two-fifths as long as pronotum; pronotum much wider than collar, with hind margin slowly rounded, not covering small scutellum; paranotum rather narrow, areolate not plainly visible, reflexed upright opposite humeral angles, resting against surface of collar. Laminae of rostral sulcus areolate, open behind. Legs long, femora somewhat ganulate.

Elytra extremely large, very broad, cordate, widest a little in front of middle, meeting in a straight commissure behind scutellum, about width of costal area longer than abdomen; stenocostal area narrow, uniseriate, slightly reflexed; costal area very wide, composed of six irregular rows of areolae; subcostal, discoidal, claval, and sutural areas fused, not clearly distinguishable from one another. Metathoracic wings obsolete.

Holotype (male), Lord Howe Island, South Pacific Ocean, east of New South Wales. Illustrated.

Separated from *A. cordata* (Hacker) and *A. leai* (Hacker) by the slightly more petiolate compound eyes and especially by the much narrower and more reflexed paranota. The cephalic spines (two pairs in front of eyes) are long in *A. leai* whereas they are short, tuberculate in the other species.

Subfamily TINGINAE Laporte

Tingis drakei Hacker, Lord Howe Island; *Euaulana tasmaniae* Drake, Mount Compass, South Australia, on *Banksia* sp.; *Malandiola semota* Drake, Everard Range, South Australia; *Paracopium australicum* (Stål), Townsville, Queensland; *Compseuta lefroyi* Distant, Rockhampton, Queensland; *Oncophysa vesiculata nigra* Hacker, Mount Arthur, Tasmania; *Hypsipyrgias telamonides* Kirkaldy, Woodford, Queensland; *Parada taeniophora* (Horváth), Dorrigo, New South Wales; *Nethersia maculosa* Horváth, Central District, Western Australia; *Diplocysta trilobata* Drake, Nuriootpa, South Australia; *Eritingis trivirgata* (Horváth), Cairns District, and Kuranda, Queensland; *E. koebeli* (Drake), Myponga, South Australia; *E. aporema* Drake and Ruhoff, Myponga, Flinders Island, and Loxton, South Australia; *Stephanitis pyrioides* (Scott), Lane Cove, New South Wales, Apr. 28, 1946, on *Azalea* leaves.

Cysteochila aletheia, sp. nov.

Small, oblong, testaceous with head, disc, apex of triangular process of pronotum, most veinlets of paranota, and transverse band near middle of elytra (including most of discoidal areas) dark to reddish brown. Body beneath brownish with mesosternum blackish. Antenna testaceous with first two and fourth segments dark brown. Legs testaceous, tips of tarsi dark. Rostrum brownish-testaceous. Hind wings clouded with fuscous. Length 2.50 mm., width (elytra) 0.92 mm.

Head very short, little produced in front of eyes, armed with two pairs of stout, moderately long spines, hind pair appressed, front pair porrect; eyes moderately large, reddish. Antennae fairly long, slender, smooth, measurements: segment I, 0.10 mm.; II, 0.08 mm.; III, 0.90 mm.; IV, 0.54 mm. Rostrum extending to middle of mesosternum; laminae of sulcus uniseriate, with a wide V-shaped opening at base. Bucculae areolate, closed in front.

Pronotum moderately convex, punctate, tricarinate; median carina moderately raised, composed of one row of small areolae; lateral carinae less raised, without distinct areolae, divergent posteriorly, barely covered on pronotal disc by reflexed paranota; hood small, inflated, highest near middle of crest, produced slightly forwards in front and extending backwards between calli to base of pronotal disc; paranotum very large, reflexed so that outer margin rests on lateral carina. Ostiole and ostiolar canal present on each metapleuron. Legs smooth, femora slightly swollen.

Elytra with areolae neatly arranged in rows, sutural areas overlapping each other at rest; costal area moderately wide, biseriate, areolae subquadrate and hyaline; subcostal area narrower than costal area, nearly vertical, biseriate; discoidal area large, about four-sevenths as long as elytra, acutely angulate at base and apex, widest near middle, there six areolae deep; sutural area with areolae slightly larger than in discoidal area.

Holotype (male), Bisiatabu, Port Morseby, Papua Territory, New Guinea, W. N. Lock; *allotype* (female), Mount Lamington, northeast Papua, New Guinea, elevation 1,300-1,500 feet, C. T. McNamara. *Paratype*, 1 specimen, same label as allotype. All macropterous.

Hypsipyrgias euphues, sp. nov.

Macropterous form: Moderately large, oblong, reddish brown with pronotal disc and head (not spines) black. Body beneath black, slightly shiny. Antenna brown with segment IV black. Legs brown with tips of tarsi dark. Length 3.00 mm., width (elytra) 0.68 mm.

Head very short, little produced in front of eyes, armed with five long brownish spines, hind pair of spines appressed, frontal three porrect. Antenna rather slender, measurements: segment I, 0.12 mm.; II, 0.08 mm.; III, 0.88 mm.; IV, 0.28 mm. Labium reaching base of mesosternum, brown; sternal laminae of sulcus brownish, low, uniseriate, open behind. Metathoracic scent glands with ostiole and vertical channel on each metapleuron.

Pronotum moderately convex, punctate, tricarinate; hood large, pyriform extending backwards slightly beyond middle of pronotal disc, not covering lateral carinae, not produced anteriorly over base of head, much longer than wide or high; median carina terminating anteriorly at base of hood, uniseriate on pronotal disc, less raised and without areolae on hind projection; lateral carina entirely exposed, strongly constricted at base of pronotal disc, terminating in front at calli, composed of one row of areolae on pronotal disc, without cells on backward projection of pronotum; paranotum moderately wide, long, reflexed almost against pronotum, triseriate, the outer row of cells resting flatly on pronotal surface; triangular process areolate, with a small tumid area at apex.

Elytra constricted behind middle, sutural areas overlapping each other in repose; costal area narrow, composed of one row of small areolae; subcostal area nearly vertical, composed of two rows of quadrate areolae; discoidal area large, extending beyond middle of elytron, acutely angulate at base, obtusely angulate at apex, widest behind middle, there six areolae deep. Hypocostal lamina uniseriate. Exterior margins of elytra and basal margin of paranota finely serrate.

Holotype (male) and *allotype* (female), Lord Howe Island, A. M. Lea. *Paratypes:* 2 specimens, same labels as type.

Differs from *H. telamonides* Kirkaldy, of Australia, by its much smaller hood (not concealing lateral carinae from dorsal view) and smaller tumid area of backward projection of pronotum.

DESCRIPTION OF PLATE 7

Fig. 1. *Gonycentrum socium* Drake and Ruhoff. Fig. 2, *Allocader nesiotes* sp. nov.

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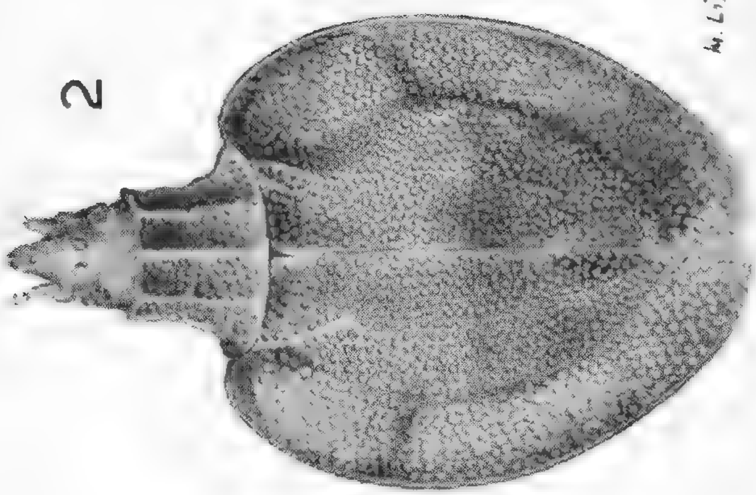

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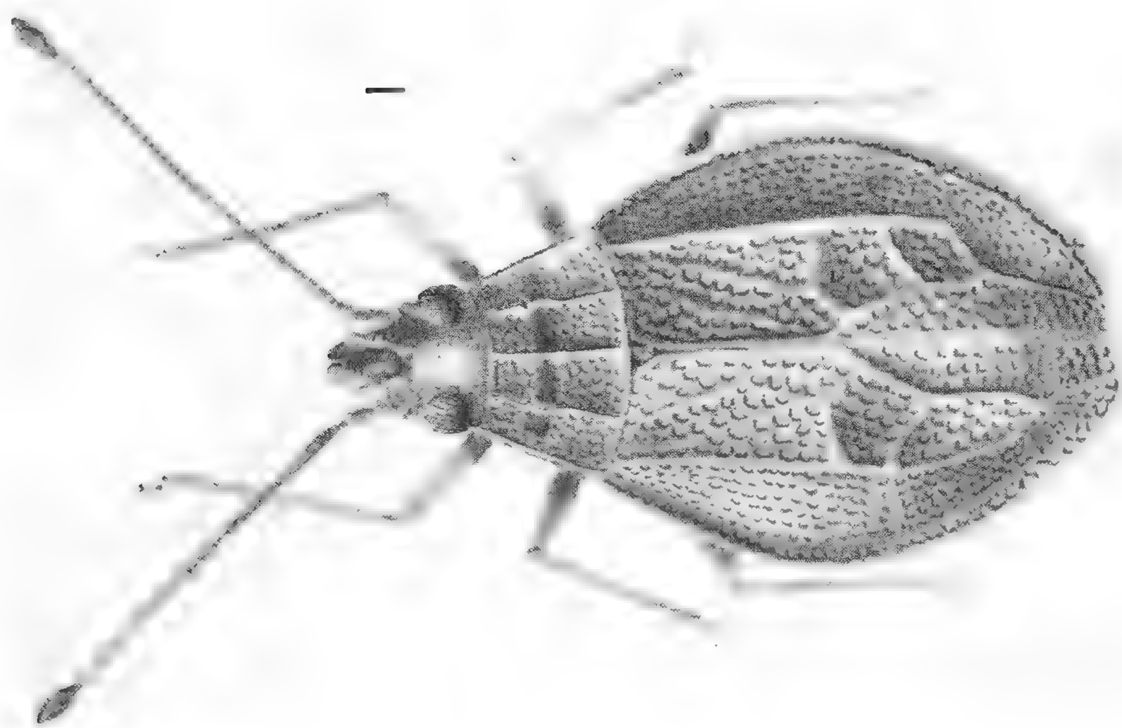

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NEW HYLID FROG FROM THE CENTRAL HIGHLANDS OF NEW GUINEA

BY MICHAEL J. TYLER

Summary

In a check list of the amphibians of New Guinea Loveridge (1948) recognized thirty-five species of the genus Hyla. Of these, H. becki, H. darlingtoni and H. angularis had been described by the same author (1945) from specimens collected in the Central Highlands of the Australian Trusteeship Territory. The herpetofauna of this region is very imperfectly known, and the only other Hyla species recorded from the area are H. angiana Boulenger and H. arfakiana Peters and Doria (Forcart, 1953).
Included in a collection from the Central Highlands, made by the writer in 1960, is a species of Hyla considered to represent an undescribed form.

Hyla iris sp. nov.

Holotype: British Museum No. 1961.1206. A male collected at Bamna, near Nondugl (Lat. 5° 49´S.; Long. 144° 44´ E.) at 6,500 feet, 16 April, 1960.

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Fig. 1

INTRODUCTION

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A pygmy species mature at approximately 27 mm. body length, most closely related to *H. pygmaea* (Meyer), but clearly distinct from that species. The specific name of *iris* is derived from *iris* (*L.*): "rainbow," and refers to its multicoloured appearance in life.

Holotype: Vomerine teeth poorly developed, in two slightly raised, short, oblique series, separated from each other and from the small rounded choanae by a distance slightly greater than the length of one of them; tongue less than half as wide as mouth opening, almost oval, its posterior border not emarginate; snout elongated, sharply pointed when viewed from above, concave in profile; nostrils more lateral than superior, prominent, their distance from end of snout about three-quarters that from eye, separated from each other by an interval equal to about one and one-half their distance from eye. Canthus rostralis rounded and depressed; loreal region concave and oblique. Eye large, its diameter almost one and one-half times its distance from nostril; interorbital distance one and one-half times the width of upper eyelid. Tympanum very distinct, about two-fifths the diameter of eye, separated from eye by a distance half its own diameter.

First finger webbed at base, second, third and fourth by loose fold to disc, consisting of broad fringe beyond sub-articular tubercle of third; disc of third covers tympanic area; second, third and fifth toes webbed to discs, the web on first and fourth toes reaching subarticular tubercles at base of penultimate phalanges, continuing to disc as fringe covering about one third the tympanic area; a distinct oval inner but no outer metatarsal tubercle; no tarsal ridge; no dermal appendage on heel. Body elongate, in post-axillary region two-thirds the greatest width of head; when hind limb is adpressed, heel reaches nostril; when limbs are laid along the sides, knee and elbow do not overlap; when hind limbs are bent at right angles to body, heels overlap slightly. Skin of upper parts deeply etched, skin of throat and thorax slightly granular, abdomen and posterior surface of thighs coarsely pustulose. Skin of head not co-ossified with skull, roof of skull not exostosed. Vocal sac apparently internal with paired openings in floor of mouth at base of tongue; nuptial pad on first finger.

Dimensions: Snout-vent length 28.4 mm.; head length 9.0 mm.; head width 8.5 mm.; femur 14.4 mm.; tibia 15.4 mm.; foot 11.5 mm.; hand 8.3 mm.

Colour in alcohol: Dorsal surface of head, body and limbs dark slate blue; tip of urostyle cream; side of head similar to dorsal surface with short cream stripe extending from angle of jaw to below tympanum; elbows cream; lateral surface of body with large, oval white patches; axilla black, groin dull violet. Throat and thorax white, colour of abdomen determined by viscera seen in transparency; posterior surface of thighs violet inferiorly, cream on blue-black superiorly. Palmar and plantar surfaces cream; first and second fingers cream above, third and fourth toes lightly pigmented blue-black.

Colour in life: Dorsal surface of head, body and forelimbs pale green lightly stippled with black; tip of urostyle cream; side of head pale green with pale yellow stripe from angle of jaw to below tympanum; elbows pale yellow; lateral surface of body deep violet with oval white patches; axilla black; groin violet, variegated with pale sky blue. Throat, thorax and lower surface of limbs pure white; abdomen pale cream; posterior surface of thighs green variegated with vivid orange. Palmar and plantar surfaces pale yellow; first and second fingers white, third, fourth and toes green barred with yellow.

Variation: Paratypes: 21 ♂♂ 4 ♀♀ 1 juvenile—Australian Museum Nos. R.16832-16836; British Museum Nos. 1961.1207-1226.

All but one of the paratypes were collected at the type locality during the interval between 16th and 24th April 1960. The exception (B.M. 1961.1226) was collected at 9,500ft. on the Wahgi-Sepik Divide north of Banz (approximately eight miles west of the type locality), on 20th May, 1960.

Body length: 27.5-30.7 mm. ♂♂; 34.4-38.0 mm. ♀♀; 15.4 mm. juvenile.

As is indicated by the body lengths, the paratypes form two sexually homogeneous groups. The hind limbs of the females are relatively shorter than those of the males, reaching the eye, or between the eye and the nostril, as opposed to reaching the nostrils in males. This is demonstrated by the tibia length/snout-vent length ratios:

Females	Range: .526-.587	Mean: .552
Males	Range: .503-.551	Mean: .526
Juvenile	.442	

Vomerine teeth are poorly developed in the entire series, and absent in the juvenile. The degree of webbing of the fingers and toes of the paratypes is similar to that of the holotype. Vocal sacs and nuptial pads are present in all male paratypes. The latter are rugose and pigmented in sixteen specimens, but raised yet unpigmented in four. A typical example (B.M. 1961.1215) of a nuptial pad is illustrated in fig. 1.

The variation of colour of adults in life was restricted to the dorsal surface of the head and body, where the pale green was frequently blotched with black. In alcohol this has resulted in a restriction of the slate coloured markings to occasional patches.

The colour in life of the juvenile was, dorsally a uniform dark green; side of head similar with bright cream patch behind eye. Lateral and ventral surfaces of body bright cream. Limbs orange above and at sides, except humerus which was bright yellow.

Comparison with other species: The small size of *H. iris* is shared by relatively few of the New Guinea representatives of this genus. *Hyla wolterstorffi* Werner was described from a specimen with a body length of 23 mm., but this species has unwebbed fingers, and bears no resemblance to *H. iris*. *H. becki* was found in the same region as *H. iris*, and is quite distinct from it.

When specimens of *H. iris* are checked against the key to New Guinea *Hyla* prepared by van Kampen (1923), they run down to *H. fallax* Boulenger (listed as a synonym of *H. pygmaea* (Meyer) by Loveridge (1948)). A direct comparison with specimens in the British Museum collection (B.M. 1913.11.1.152-153) has been made, and affinities with this species appear closer than with any other.

Fig. 1. Nuptial pad of *Hyla iris* paratype (B.M. 1961.1215).

Hyla pygmaea, as represented by the British Museum specimens, may be clearly distinguished from *H. iris* by a comparison of the vomerine teeth and choanae. The latter are rounded in *H. iris* and oval in *H. pygmaea*. The vomerine teeth of *iris* are poorly developed and separated from each other and from the choanae by a distance greater than the length of one series, as opposed to well developed, and one-third of their length and twice their length respectively. *Hyla* *pygmaea* has a relatively larger head, and the dorsal surface of the head and body is usually pale brown with large white markings upon it, as opposed to green with black stippling or patches.

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GEOGRAPHICAL KNOWLEDGE OF THE KAIADILT PEOPLE OF BENTINCK ISLAND, QUEENSLAND

BY NORMAN B. TINDALE, CURATOR OF ANTHROPOLOGY AND ACTING DIRECTOR, SOUTH AUSTRALIAN MUSEUM

Summary

This paper gives an account of the native geography of Bentinck Island and vicinity, the home of the Kaiadilt, an isolated Australian aboriginal tribe of eight hordes. There is a map showing the place names and general configuration of their country.

The Kaiadilt remained aloof from direct European associations until the period between 1945 and 1948 when an extraordinary series of natural events, including drought and a tidal wave combined with quarrels and many accidental drownings caused a major decline in population. The people were taken to Mornington Island where they now live in a small endogamous community among people of the Lardiil tribe.

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Plates 8-9, text fig. 1 and Map A

CONTENTS

SUMMARY

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population. The people were taken to Mornington Island where they now live in a small endogamous community among people of the Lardiil tribe.

These people otherwise are of interest because of their special physical characters and because they have retained until now knowledge of the manufacture and use of simple stone tools of a predominantly biface palaeolithic tradition which did not survive elsewhere into modern times except among the Lardiil people of Mornington Island, although found along the coast of N.W. Australia as archaeological relics.

There is a summary of the history of early contacts and a general description of the geography of parts of the island visited by the author during May 1960 in company with D. L. Belcher, P. Aitken, Gully Peters and some twenty Kaiadilt helpers.

INTRODUCTION

This paper gives a brief outline of the geographical knowledge of the very isolated people of Bentinck Island, Queensland, and some account of the history of contacts between them and members of the Western world up to the time of their removal to Mornington Island in 1947-48. There is a summarized account of the physical surroundings of the island. Some details are given of the native nomenclature of their various camping places and of those geographical features in their country which they regard as important.

The island is of particular interest to anthropologists because of the isolation of these people and to historians because it was one of the first parts of the Gulf of Carpentaria examined in detail by Matthew Flinders in 1802; he met North Australian aborigines face to face in this vicinity for the first time. Following his brief encounter these aborigines, who today call themselves Kaiadilt [′Kaiadil, ′Kaija:dil, ′Kaiadilt], remained isolated and away from Western contacts for another 145 years, to become the very last tribal group of coastal Australian aborigines to meet the civilized world.

To anthropologists they are physically of special interest because they are unique in Australia in possessing a high incidence of B blood, and culturally for their continued use of some very simple forms of Palaeolithic stone tools, of types which have long fallen out of use in the rest of the world. Details of their anthropology, blood genetics and population statistics are the subjects of separate papers in preparation and in press (Tindale 1962; Simmons, Tindale and Birdsell *in press*).

Transcriptions of geographical names within the text of this paper conform to the conventions of spelling called "Geographic II", the officially accepted method. Where greater accuracy of transcription of some Kaiadilt words is desirable, a version within square brackets has been given in the script of the International Phonetic Alphabet, as adapted for Australian languages, and conveniently set out in the Transactions of the Royal Society of South Australia, 64, 1940, at p. 147. For publishing economy black letter and italic type are used for the differentiation of some vowel sounds and consonants. In the accompanying map, letters with a vertical stroke beneath them correspond to those shown in **black letters** herein; those with a dot beneath them are indicated in the body of this paper by *italics*. It will be noticed that in the 1940 list the symbols θ and ð were accidentally transposed in the table. θ is of course the unvoiced, and ð the voiced *th* sound. The symbols have been correctly used in all published texts given in the script.

In the Kaiadilt language θ occurs only rarely, as in the word [ˈra:rθ] which means south. A very strongly rolled r is present but not universally used; when it appears in a word the terminal vowel usually disappears.

DISCOVERY OF BENTINCK ISLAND

Supposedly earliest observations made in the vicinity of Bentinck Island were by Jan Carstensz, commander of the ship *Pera* in 1623, who sailed along the Cape York coast of the Gulf of Carpentaria as far south as Staaten River. As quoted by Flinders (1814 p. xi) "in this discovery were found, everywhere, shallow water and barren coasts; islands altogether thinly peopled by divers cruel, poor and brutal nations". The Gulf of Carpentaria itself was named after Pieter de Carpentier, Governor-General of the Dutch East Indies from 1622-1628. The name of the Gulf was not used in instructions given to Abel Tasman for his second voyage in 1644. He is thought to have followed the coast of the Gulf and to have furnished data for Thevenot's chart of 1663, but his journals seemingly have not survived.

Malayan fishermen probably ventured as far as these islands long before Flinders' visit and the presence of planted tamarind trees, first noticed in the 1880's suggests they had camped on Fowler Island during visits to fish for trepang and other marine products.

Flinders (1814 p. 147) reported traces of what he interpreted as the presence of strangers on Sweers Island in the form of seven human skulls. He saw many bones lying together near three extinguished fires and elsewhere a squared piece of timber, seven feet long, which was of teak wood and considered to have been a quarter-deck carling of a ship. The last named was thrown up on the western beach. On Bentinck Island he saw stumps of at least twenty trees which had been felled with an axe, or some sharp instrument of iron, and not far from the same place were scattered the remains of an earthen jar. He inferred that a ship from the East Indies had been wrecked within the previous two or three years, part of the crew had been killed and others might have gone elsewhere upon rafts constructed after the manner of the natives.

Sweers Island, the eastern-most of the Bentinck Island group was the first high ground in the Gulf of Carpentaria seen by Flinders. He describes his first anchorage at the southern end of the island but makes no reference to a low rounded island known to present day Kaiadilt aborigines as Dingkari ['Diŋkari]. This islet lies due south of Bardatur ['Bardatur]. Dingkari is stated to be a nesting place for gannets and on our visit they were seen flying there. Between it and Sweers Island is a reef called Karandjalt ['Karandjalt].

Flinders anchored off Bardatur and on 17 November 1802 landed on the beach called Tjilki ['Tji:lki] making his way to Inspection Hill, a limestone elevation 104 feet high, from which he had his first extensive view of the island group. This hill is the Durakara ['Du:rakar, 'Du:rakara] of the Kaiadilt; the name is applied specifically to the supposedly never-failing spring which oozes from rocks at the eastern base of the hill and trickles into the sea at low tide from small rock pools. This water is quite fresh.

Flinders found safe anchorage off the western point of Sweers Island, known to present day natives as Milt ['Milt], and after exploring to the west spent several weeks repairing his ship.

He described his one close encounter with the aborigines, near Allen Island on the 20th November 1802, in the following passages. "I went eastward to a smaller island, two miles off, where several Indians were perceived. The water was too shallow for the boat to get near them; but we landed at a little distance, and walked after three men who were dragging six small rafts toward the extreme northern rocks, where three other natives were sitting.

"These men not choosing to abandon their rafts, an interview was unavoidable, and they came on shore with their spears to await our approach. One of us advanced towards them, unarmed; and signs being made to lay down their spears, which was understood to mean that they should sit down, they complied; and by degrees a friendly intercourse was established . . . The rafts consisted of several straight branches of mangrove, very much dried, and lashed together in two places with the largest ends one way, so as to form a broad part, and the smaller ends closing to a point. Near the broad end was a bunch of grass, where the man sits to paddle, but the raft. with his weight above, must swim very deep; and also I should scarcely have supposed it could float a man at all. Upon one of the rafts was a short net, which from the size of the meshes was probably intended to catch turtle; upon another was a young shark; and these, with their paddles and spears seemed to constitute the whole of their earthly riches . . .

"After being five minutes with them, the old men proposed to go to our boat; and this being agreed to, we proceeded together, hand in hand. But they stopped half way, and retreating a little, the oldest made a short harangue which concluded with the word *jahree!* pronounced with emphasis; they then returned to the rafts, and dragged them towards their three companions, who were sitting on the furthest rocks. These I judged to be women, and that the proposal of the men to go to our boat was a feint to get us further from them; it did not seem, however, that the women were so much afraid of us, as the men appeared to be on their account; for although we walked back, past the rafts much nearer than before, they remained very quietly picking oysters. It was not my desire to annoy these poor people; and therefore leaving them to their own way we took an opposite direction to examine the island."

The rafts, shell water vessels, fish nets, and fillets described by Flinders are still in use.

In addition to the six natives on Horse-shoe Island, natives were repeatedly seen both on Sweers and Bentinck Islands and one of his officers found a small hole containing a little muddy water with a shell lying near it. This was dug out to become the well near Milt which has remained in use up to the present time.

The natives were elusive. Fireplaces were found under trees and one instance a large hole was found to contain two "apartments" in each of which a man might lie down. Flinders considered these "caves" to be their foul-weather residences and the fireplaces under the shade of the trees, with dried grass spread around, their fine-weather camps. The earth of dry swamps was found to be so dug up with pointed sticks that it resembled the work of a herd of swine. He inferred that they obtained a "fern or similar root" from the mud.

The next available account of Bentinck Island commences on 8 July 1841. Captain J. L. Stokes, while sailing into Investigator Road, observed a party of twelve natives under "Mount Inspection" at the south-eastern extremity of Sweers Island. They gazed at his vessel without demonstration as it passed. Presumably they were congregated near the spring called Durakara at the eastern base of the hill. Aborigines were subsequently heard, uttering a cry like "cooey", but they did not show themselves again. He found the well dug by Flinders half a mile east of Milt, to which he gave the name Point Inscription, adding the name of his ship, the *Beagle,* to a tree inscribed by Flinders, and sent his officers to examine the coast of Bentinck Island. Karnkai ['Karn'ka:i], the eastern extremity, he named as Raft Point, from having noticed native craft there. On Sweers Island he found exposed a native skull with forearm, left tibia and part of a maxilla. Modern Kaiadilt custom is to bury those who die natural deaths, leaving exposed bodies of any killed in combat and those remaining unavenged. Stokes gave the name of Fowler Island to Baltae ['Baltae, 'Ba:tae], noting its reefs and a mangrove fringe on the south side, now a dense forest of black mangroves. In his description he states that this islet forms the "immediate eastern side of the Road"; evidently this is a slip of the pen for "western side".

A Mr. Forsyth was sent to explore the islands of the Wellesley Group. He reported that after leaving Allen Island he had seen some natives on the ironstone cliff at the south-eastern extremity, that which is called Modomodor ['Modomodor] by the present day Kaiadilt; the name appearing on modern official maps is Point Creffild. Other data recorded about the Group was the taking of 151 quail, 3 plover, 20 pigeons, 3 "pheasants", 8 white and 2 black cockatoos and 5 spurwing plover, all recognizable as species of birds seen in 1960. He noted clouds of "locusts" forming a complete curtain over Sweers Island. They diminished in numbers after a few days. Two species of large grasshoppers were abundant, but not in plague numbers, during our visit in 1960; one of them is used as food by the aborigines.

From his observations it may be assumed that three separate groups of aborigines were present on Bentinck, Sweers and Allen Islands, in July 1841.

These were the same three areas in which aborigines were noted by Flinders in 1802.

On 31 December 1861 a naval vessel, H.M.C.S. *Victoria* visited Sweers Island and James Frost, a gunner, who had been accidentally killed by the discharge of a gun, was buried there in a grave still marked by a headstone.

In 1865, shortly after the founding of Burketown, an epidemic of sickness caused a general evacuation to a temporary settlement on Sweers Island. The Gulf country was gradually abandoned again in the following three years, but some residents remained. Nothing is known about the relationships between these settlers and the aborigines; it is probable that there was no contact.

On 4 February 1874 Donald McLennan, who died at the age of 46 years, was buried beside the grave of James Frost. The nature of his association with Sweers Island is unknown.

In 1880 Captain Pennefather furnished a report to the Queensland Government on exploration in the Gulf of Carpentaria. He landed on Sweers Island on 15th September 1880 and found it to be occupied, and overstocked, with 1,200 head of cattle, sheep and goats. There were two coconut trees, guavas, dates and tamarinds. There were only ruins remaining of William Landsborough's "once thriving town of Carnarvon". Of the adjoining island he says, "Visited Bentinck Island, which is fairly grassed, and timbered with stunted bloodwood, Moreton Bay Ash, fig trees, etc. Saw a large mob of natives, who did not allow us to approach them. On the south side of the island there is a freshwater lake. Bentinck is about ten miles long by five or six miles wide. On Fowler Island (a small island between Bentinck and Sweers) tamarinds, supposed to have been planted by the early Dutch navigators, are growing and bearing luxuriantly".

The reference to the freshwater lake indicates he visited Njinjilki, and the elusiveness of the aborigines is in keeping with their earlier and their later behaviour. From his account it seems likely that up to the end of the 19th century no very close contacts, other than the initial brief one by Flinders, had been made with Bentinck Islanders.

CONTACTS WITH BENTINCK ISLANDERS.

First 20th century contact was in June, 1901, when Dr. Walter Roth, Protector of Aborigines for North Queensland, with a party of native police, accompanied by John Frederick Bailey, then Director of the Botanic Gardens, Brisbane (later of Adelaide), and Charles Hedley, Zoologist of the Australian Museum, Sydney, landed on the island.

The visit is not well documented. Search has failed to trace reports; there are entries in official letter books but the letters themselves have disappeared. Diaries appear not to have survived, either in Australia or in British Guiana, where Dr. Roth died.

Roth (1906, Bulletin 6, p. 23 and 8, p. 6) speaks briefly of three visits to Bentinck Island, saying that on only one visit was he able to come into "direct touch" with the aborigines owing to their timidity. He "met" a group of young girls, six or more, under guard of a very old man but was not able to learn anything for lack of a common tongue. Among the party, on what presumably was this occasion, was Ned Scott, who gave MacIntyre (1921, unpublished manuscript in Mitchell Library, Sydney) an eye-witness account:—

> "Dr. Roth . . . tried to corner a lot of them on Bentinck but after being pushed up to one end of the island by a drive they took to the reefs right out at sea, and he [Scott] was sent in the boat around them to hunt them ashore, he did so but in the landing charge Roth and party only caught one or two old gins and could not do much with them, they were livid with fear and howled like a dog."

Bailey took a series of photographs of which negatives, labelled "Bentinck Island 1901", have survived. There also are a few specimens in the Brisbane Herbarium collected by J. F. Bailey and labelled "Bentinck Island, June, 1901".

Plate 8, fig. 1 and 2 show some excited aborigines who were seen on this occasion. The encounter appears to have taken place near Karukai (Raft Point) the south-eastern extremity of the island and the natives describe how their parents attempted to conceal themselves under debris, standing up to their necks in water on the outermost edges of the reef.

The aborigines themselves have traditions of a later hostile attack with guns by a white party, probably about 1918, but of this no official documentary record exists.

The name of a white man, MacKenzie, whose first name is believed to have been John, appears in association with Bentinck and Sweers Islands during the second decade of this century when he was the builder of a lime kiln on Sweers Island. Mrs. R. H. Wilson, wife of the early missionary at Mornington Island has recollections of a physically big man, an elderly rugged individual, whom she first met about 1923. He was then about 60 years of age. MacKenzie became skipper of the auxiliary ketch *Maura* trading between Burketown and

Boroloola. According to Mission records *Maura* first visited Mornington Island on 5 August 1922.

It is possible that MacKenzie accompanied Dr. Roth on the 1901 visit to Bentinck Island for he is thought to be the one who gave Mrs. Wilson a print from one of the Bailey photographs; it is endorsed "Bentinck Isd., June 1901", helping to confirm the date of Roth's visit.

About 1914 MacKenzie had attempted to settle on the south coast of Bentinck Island and built a hut near Kombali ['Kombali]. He could make no friendly contacts with the aborigines, and well before 1917 had abandoned the hut, transferring his activities to Sweers Island where he also built a house, kept goats and horses, and constructed the lime kiln by mining a chimney hole into the western side of Inspection Hill. His unauthorized attempt to settle on Bentinck is referred to as a past event in official reports written in 1917. He continued to burn and sell lime in Gulf ports until 1922. No friendly contacts were made with Bentinck Islanders. He employed two Lardiil aborigines from Mornington Island for a short time. One of them, "Old William", has described his unhappy experience of lime handling on a diet of goats' heads and livers, and told of their return to Mornington Island in August, 1920 after escaping to the northern end of Sweers Island and signalling to the passing Mission vessel, the *Morning Star*. At that time MacKenzie had as helpers one white man, a Normanton blackfellow, a half-caste named Roger Thompson, and three Malay/Aboriginal half-caste brothers whose family name was Samardin. A white man named Nelson was his partner for some time.

After MacKenzie abandoned Sweers Island the Bentinck Islanders made return visits to it. One youth, Tarurukingati ['Tarurukiŋati] was given the totemic name of Tungalngomoro ['Tuŋalŋo'moro] said to be a name they had applied to a "black goat" abandoned by MacKenzie. Stories are told also of efforts to hunt down and spear the last of MacKenzie's abandoned horses. Horses teeth said to be those of this animal were picked up and given to us in 1960. Much debris of European occupation was left on Sweers Island both by the earlier abortive settlements commencing in the 1860's and by MacKenzie, but the aborigines seem never to have made use of any of the material, unless several well worn nether millstones, of dark basaltic rock, present at Minakuri, originated from ballast dropped from some ship.

Systematic efforts by Mornington Island Mission officers to come into contact with Bentinck Islanders first began in October 1925 when gifts for Bentinck Islanders were left on the beach while on a voyage to the mainland. According to present day Islanders these gifts were not appreciated; the tobacco being particularly repugnant; it and the food were buried; a matter now of much amusement to them. In September 1926 Mornington Islanders began working off-shore reefs around Bentinck Island for beche-de-mer, then an important article of trade with China, and a source of Mornington Island Mission revenue. Gully Peters, a leading Mornington Islander, then a young man, succeeded in coming close to an old woman on a reef and attempted a conversation. Baltae (Fowler Island) became a base camp for trepang curing operations. On several occasions during the first season aborigines were seen in the distance on the main island, opposite this camp. In some published Mission reports the name of Sweers Island is used as name for this base, an error of identification. All such activities were in fact centred on Fowler Island, as confirmed in a recent letter from Cora, half-caste wife of Gully Peters.

Prior to 1927 the Lardiil had not met any Kaiadilt people at close quarters. Late in that year, a message indicating that a friendly contact had been achieved, was sent by Gully to the Mission Superintendent, Mr. R. H. Wilson, who made a visit and saw several men "together with some very young women". They were "exceedingly timid". Photographs of this or the next occasion are available. For copies of these I am indebted to his son the Rev. Andrew R. Wilson, of Brisbane. Plate 9, fig. 1, of which the original is rather faded, depicts thirteen natives hurrying away from the camera. The print is one that had been slightly retouched to disguise the nudity of the people.

A second contact was made in late 1927; meetings with 48 persons (12 men, 16 women and 20 children) are mentioned in reports dated 5 February, 1928. Mrs. Wilson was present on the second visit and was taken into the bush on the main island where she saw and was photographed with women and children (plate 9 fig. 2). Shortly afterwards relationships with Bentinck Islanders deteriorated. They began to steal and to prevent hostilities, beche-de-mer operations were suspended. They were never resumed because a drastic fall in the market price for that product destroyed the industry.

The late Mr. J. Bleakley, Chief Protector of Aboriginals in Queensland, in a book just published, states that he made several official visits to Bentinck Island. On the first, in 1915, he saw light flares carried by people fishing by night on reefs, but made no contact. On a second official visit, made apparently as a result of Rev. Wilson's first encounter in 1927, he briefly met some natives face to face. The photograph on plate 9, fig. 2, probably was taken on this occasion. The people were very timid.

In 1937 Bleakley made a further landing with a party of Government Ministers and was met by the same short-statured old man whom he had seen on his earlier visit. In his book (Bleakley, 1961), he refers to reports "that skeletons had been found with what appeared to be bullet holes in them". He leaves conjecture open as to the perpetrators of any outrage.

In late 1940 while on a journey to Burketown in a Mission dinghy, Mornington Islanders landed on the northern end of Allen Island, and one of them, "Cripple Jack", was killed by members principally of the west-most horde or *dolnoro*, the X *dolnoro* of the map. These Bentinck Islanders had gone to Allen Island by raft to escape friction on Bentinck Island; some had been drowned while making the journey. Police seized the offenders and after trial, members of this temporary Allen Island community, numbering eleven in all, were taken to Aurukun Mission on the eastern coast of the Gulf where they remained until 1953. This was the first direct alteration imposed on the Bentinck Island population.

In October 1943, a Royal Australian Air Force party in a launch were anchored off Milt (Inscription Point), Sweers Island, during a gale. They were attacked by a party of Islanders who threw spears; in warding them off one native (named Kongarangati dawart) was killed. After some months, when a visit of enquiry was made the body of this native was found as left, and buried. Several wary Bentinck Island men were seen and spoken to at a distance.

In early June 1945 Gully Peters who had been for so long a leader in attempting to make contact with the Kaiadilt and had been present on the launch during the attack at Milt, took the Mission launch *Albinia* to the western end of Bentinck Island. He had a friendly meeting with the Bentinck Islanders and on 6th June returned to Mornington Island with 29 persons aboard. These people were of more than one western *dolnoro*, including six men, four boys, thirteen women and six children. A month later, after seeing life on a Mission Station, these people were taken back to Bentinck Island.

In September and October 1946 drought conditions prevailed in the area. Brief contacts were made with Bentinck Islanders while searches were being made for the *Albinia* which had disappeared in a storm, with all hands. At first it was thought the Islanders had been responsible for her loss.

On 10 June 1947 a young Bentinck Island male, two women and a boy and girl were found in distress on Allen Island, remnants of a party which had fled from Bentinck Island after a fight. They were suffering from a shortage of water and were removed to the Mission.

On 3 August, 1947, Mission Superintendent J. B. McCarthy found 42 men, women and children on Sweers Island and took them to the Mission. They were in poor condition because of the drought. Dr. J. A. Spalding examined these people in December 1947 and also visited Bentinck Island, himself suffering shipwreck during the return voyage. He noted the presence of some edible berries, fruits, roots and grasses on the banks of the Markaruki river. Ten of seventeen children examined by him showed some degree of malnutrition. He noted that smears were negative but that symptoms of "chronic lung infections ? tuberculosis" were present, mainly among women. Hookworm was absent. He concluded that the Bentinck Islanders were rapidly dying out and ascribed their decline to "(1) tribal warfare, (2) disease, mainly tuberculosis (?) and dysentery and (3) malnutrition among the young."

The aborigines still remaining on Bentinck Island in February 1948 suffered the effects of an extraordinary high tide or tidal wave, described elsewhere in this paper. This appeared to be a culminating event in the deterioration of the homeland of the Kaiadilt.

Drought conditions continued in the Gulf of Carpentaria during 1948 and because of the tidal wave the main coastal waterholes on Mornington Island were salty. Alarm was expressed at the possible fate of the remaining population of Bentinck Islanders and smoke signals seen were interpreted as being distress calls. A police party in the launch *Marlin* therefore went to the island on 16th October 1948. According to a report by Missioner McCarthy they found pot holes dug along the beach, all of them dry; the usual camps were deserted; one hole at the eastern end of Dalwai ['Dalwai:] (Albinia Island) still contained water. Tracks were found on the south coast at "MacKenzie Creek". The whole of the area around the waterhole had been burned off and looked as if it had been ploughed, "probably by the women, digging with sticks for roots". The aboriginal explanation, given in 1960 was that water-bearing frogs had been sought in the swampy soil. Sixteen persons were found and taken to Mornington Island; three people still remained on the island. The latter were picked up during a second visit on 21st October 1948, thus bringing to a close the occupation of the island.

McCarthy's notes, written at the time, state that "Bentinck Island is in an appalling condition. There is no drinkable water in the north of the island and this has forced [the] remaining population to come together, probably for their betterment, as they had evidently hunted together and this would have assisted them very much. The physical condition of the men and women is not as bad as that of the people brought over in 1947 but the children are in very bad shape. I think my figures are correct when I estimate that there have been ten deaths among women and children and only two births since my visit in December 1947."

Since 1948 the Kaiadilt have lived in a small closed community near the Mission on Mornington Island. Here they have built their own fish traps and have learned to speak a little English. They have not married out of their community. During the visit of the author in 1960 they were studied and genealogical and other information obtained about them; the basis of several planned papers. Some of the information so gathered is the subject of a separate study on the population dynamics of Bentinck Islanders which follows this paper in these Records.

OFFICIAL AND NON-OFFICIAL NAMES APPLIED IN THE BENTINCK ISLAND GROUP

Very few official names have been proposed for features in this obscure group of islands. Nomenclators principally were Flinders, and Stokes, whose few proposals are noted on the map and in this text, together with their aboriginal equivalents. Some unofficial European names have been applied to features around Bentinck Island by crews of local vessels, by Mornington Island mission officials and by Lardiil aborigines; none of these local names appear on available official maps. The Bentinck Islanders own names are given first in the following list:—

Ngataiwind ['ŋata'i:wind]—Douglas Island, named after a member of the family of the early missionary, the Rev. R. H. Wilson.

Kandingarupai [Kandi'ŋaru'pai:]—Bessie Island, after a daughter of R. H. Wilson.

Dorati ['Dorati]—Margaret Island, after another daughter. In later reports this became McCarthy Island, but Rev. Andrew R. Wilson in a letter dated January, 1961, calls this a "ring-in".

Dalwai ['Dalwai:]—Albinia Island, after one of several small vessels of this name successively used by Mornington Island Mission.

Minakuri ['Minakuri]—Raft Point, also given as Raff Point in one report by J. B. McCarthy; not to be confused with the Raft Point of Stokes (1846) which is at the opposite or eastern end of the island.

Walpukoanki ['Walpu'koanki]—Kirk Point, also written as Kirke Point; so named by Mornington Island natives after a white employee of the Mission who walked to the Point from Minakuri while on a journey between Burketown and Mornington Island.

Baltae ['Baltae, 'Ba:tai:, 'Batae]—Hall Island; named after R. Hall, pioneer of Mornington Island Mission who once landed there prior to his murder near the Mission by Lardiil natives on 19 October 1917. Baltae is the Fowler Island of Stokes.

Dawalt ['Dawalt]—Wilson Bay; the bay between Baltae Island and Njinjilki where Rev. R. H. Wilson made his first brief contact with Bentinck Islanders, late in 1927.

Kombali ['Kombali]—MacKenzie Creek; the bay outside is called MacKenzie Bay by Mornington Island officers; so named after the man who built a hut there about 1914, but abandoned it shortly afterwards without making friendly contact with the aborigines.

ABORIGINAL NOMENCLATURE OF BENTINCK ISLAND AND VICINITY

Bentinck Islanders have their own names for their country. They divide the islands into two categories:—

Dangkawaridulk [Daŋkawaridulk] or "Men absent lands" and Dulkawalnged ['Dulkawalŋe:d] the "Land of all"; the last named is also their proper name for Bentinck Island.

The three chief Dangkawaridulk are:—

Mundamuru ['Mundamuru]—Sweers Island.

Ngakenap [ŋa:ke:nap], or Ngalkinabai [ŋalkinabai]—Allen Island.

Didjer ['Didje:r]—Horseshoe Island.

These "men-less" islands were visited from time to time when weather conditions were favourable for voyages on rafts; they could not reside permanently on them because of recurring shortages of water. Ngakenap (Ngalkinabai) was nearest the mainland coast and mainlanders were said occasionally to have come there. Ancient fights with them were remembered in tradition, but no friendly contacts. Minakuringati kulkitj, principal in the killing of a Mornington Islander on Allen Island in 1940, who had fled from Bentinck Island with "stolen" wives just prior to this attack, was probably not understating the case when he said that "Ngalkinabai was not a good place". In the late history of the islands it served as refuge on two occasions for those fleeing from quarrels on the home island. Nevertheless it should be remembered that both it and Sweers Island were in use in 1802, and again in 1846, on the two occasions in that half century when explorers made reports.

Bentinck Island itself is divided into a series of *dolnoro*, for which the term *dulmara* was obtained as a supposed Mornington Island (Lardiil tribe) equivalent. A *dolnoro* can be described loosely as a hordal territory, claimed by descendants of a common ancestor in the male line.

No fixed name is available for any *dolnoro*. Usually it is known by the name of the *dolnorodangka* ['dolnorodaŋka] who is the eldest living male of the *dolnoro*. His *-ngati* [-ŋati] or birthplace name is fashioned from the place name, using it as a differentiating prefix, *e.g.*, *Minakuringati dolnoro*, the one born at Minakuri. *Minakuringati* had another name which is totemic, *Kulkitji* (shark). In a second way of talking of dolnoro, this totemic name or tjataneda ['tjata:neda] may be employed without the *-ngati* name, *e.g.*, *Touto dolnoro* or Rainbow's *dolnoro*. This man's birthplace name was Walkareingati. These names are not universally applied since, depending on the context, one or another or both of the names of anyone of the living or recently dead members of the *dolnoro*, may on occasion serve to indicate the intended *dolnoro*. This can be confusing.

For purposes of general description on the accompanying map the location of the boundaries of the eight *dolnoro* are indicated, and each *dolnoro* is designated by a capital letter between S to Z. These symbols were allotted in arbitrary order, commencing at the northern end of the island and proceeding in a clockwise direction around it as a temporary expedient while sorting data, and have proved to be useful. The boundaries are well established. In defining their separate territories to me, while sailing along the coast, in sight of them, each informant indicated in turn the place names of his own *dolnoro*; another person automatically began to speak up at the next boundary. An interested audience listened intently and assented to each identified place name. Only at the boundary between the countries of the two *dolnorodangka* named *Minakuringati kulkitji* and *Walkareingati toato* were rival claims made. This brought out the point that a strip of about half a mile of coast-line, shown as "Disputed territory" on the map, had long been a bone of contention, a matter left unsettled when Minakuringati and his associates fled to Allen Island in 1940.

Four compass points play their part in the orientation of the Kaiadilt, and in conversation each place name on the island can be related quickly to one or other of the quadrants. These terms appear to denote the same general points as our chief cardinal ones as follows:—

Tjirkar ['Tjirkar] North, Rarth ['Ra:rθ] South, Rii ['Ri:] East, Bad ['Bad] West.

The first r sound in Tjirkar is strongly rolled as is indicated in the phonetic version of the spelling by a black letter and on the map by a stroke beneath the letter. Some people roll both r sounds in this word. The *th* in *Rarth* is an alveolar (almost palatal) θ sound which has not yet otherwise been noted in my vocabulary of the language.

For directions between these four main ones the term *ngaruwar* tends to be used, *e.g.*, *Rarth naruwar rii*, which would denote south-east, but this degree of precision is not often required. Place names from Wairil and Kadotara in the west part of the south coast, to Dangkarupuru, are *Bad* (western); from Waraburi to Kondongkuru and Dolkalatji are *Rarth* (south); from Mededingki to Bangari are *Rii* (east) and from Kongara to Ritjuro (the northmost point) and to Toltajardaruki in the west are usually defined as being *Tjirkar* (north). It will be noticed that the breaks in classification tend to occur at boundaries between *dolnoro*. Place names in the *dolnoro* areas marked on the map as W, X and Y are said to be *Bad* (west), *dolnoro* V area is *Rarth*, but only one-half of *dolnoro* area T from Bangari southward and the whole of U are *Rii* (east), while *dolnoro* Z, S and the rest of T are defined as *Tjirkar* (north).

Inspection of the imposing array of native place names on the accompanying sketch map reveals the concentration of places of interest to the Kaiadilt in the vicinity of reefs, mangrove flats, and to a lesser extent in the estuaries of the several tidal creeks, including those with rather impressive mouths and sterile clay pan hinterlands which are to be found on all sides of the island. Areas generally less attractive are the wide, more densely clothed savannah woodlands such as form the eastern "spine" of the island and the inland portions of *dolnoro* T and U and portions of territories V and Y. The greater abundance of names along the coastal strip from Ritjuro to Minakuri is a true expression of the greater richness of this side of the island as an area for living.

The map of Bentinck Island and environs on which place names are marked, is based on uncontrolled tracings from official aerial survey photographs taken on 27 September 1951 and from several oblique photographs taken on two flights over the island in 1960. The general vegetational and photographic features were checked on the ground and again during circumnavigations of both Bentinck and Sweers Islands, often at distances of only a few hundred yards from the shore. Landings were made near the three extremities of the island and at three places on Sweers Island. Portions of Bentinck Island were traversed at the south-western and south-eastern extremities where we made camps, and walks of several miles were taken from Lokoti (Rokoti) to the vicinity of Berumoi near the northern tip of the island. Portion of one day was spent on the southern end of Sweers Island in an archaeological reconnaissance near Tjilki, and an afternoon at the remains of the early attempted settlement of the 1860's and the graves of the several white visitors which are to be seen near Inscription Point. Basic purposes of the sketch map are:

(1) To give an indication of the relatively large sterile areas of claypan and mangrove swamp which reduce the areas generally considered more useful by a substantial amount of about fifty per cent.

(2) To indicate the subdivision of the island among eight native *dolnoro* (hordes) each formerly embracing some ten to thirty people.

(3) To show the multiplicity of native place names and their disposition.

As in other places where Australian hunting peoples live, the nomenclature of their country is very detailed, with place names denoting every utilized piece of country. The Kaiadilt people provide us with a most useful, because up to date, view of the native geography of a whole island.

Along the shores of Bentinck Island open sandy beaches alternate with muddy stretches sheltered by mangroves. The transition from one to the other is generally given a place name, as are the constantly recurring clumps of *Casuarina* (sheoak) trees which denote the potential presence of small seeps of fresh water coming out of the sand near tide margin. The semi-shade of several of these sheoaks forms the normal camp area of a Kaiadilt family.

Some 300 names are given and these are by no means all which are used. A few met with as birthplaces in genealogies or mentioned in texts were not encountered when on the island. It would not be surprising to be able to list 350 names in all.

More than a hundred place names were gathered in the course of genealogical enquiries before Bentinck Island was visited. These were checked and many others were gathered on the spot. Many were noticed as we sailed along the coast within sight of the specific sheoak trees, clumps of mangroves, thickets of taller trees, inlets, and beaches and particularly the many beach soaks of brackish and fresh water, both temporary and permanent, upon which they rely for their supplies.

The place names are principally found along the coast; this is not especially due to the method of collecting since the several excursions made into parts away from the shore produced relatively few terms.

Where we can be reasonably certain of the place denoted by the place name a specific location mark is given; absence of such is an indication that only the general position is known; a few are marked as of doubtful position (pd.); these are recorded on the map so that they may be the subject of further enquiry, if other opportunities should occur.

The place names have meanings but the explanation offered was often involved and in the present state of knowledge of the language it is time consuming to get details. Study of them has not yet advanced very far; some are said to be "just names", hinting that they may be of some age. Others have yielded useful leads to the mythology, etc.

A few names appear more than once. Allen Island is called Ngakenap as well as Ngalkinabai and there is also a Ngarkeinapa [Ŋarkeinapa] near the north point of Bentinck Island. There is a south coast place called Burupuri and another similarly named in the great mangrove and claypan area dominating the central portion of the island. The latter is marked as of doubtful position on the map. There is a Kalturi at the S.E. corner of Bentinck Island and another on the western side of Allen Island. The Katjuruku of the northern end of Sweers Island is a name similar to that of the wooded plateau top called Kadjuruku, inland from the prominent North Eastern point of Bentinck Island; it is also the name of a Being referred to in a later paragraph.

Many names show variations in pronunciations from the lips of different persons; in speaking the women tend to roll their **r** more than the men do. A few seem to be unable to enunciate any final **r** sounds, replacing it by a lengthening of the preceding vowel, which usually is an *a* sound. A good example is the name written in Geographic II as Karukai, the name for the eastmost point on Bentinck Island. This is on the map as [Karu'ka:i] but is also pronounced as ['Karu'kari] and as ['Karu'kar]. In the last named version the [r] is very strongly rolled. Where differences in pronunciation are extreme a second version is given on the map, in a bracket after the more usual rendering. The accepted version was that of the *dolnorodangka* of the place.

Numerous reefs and sand banks are visited on rafts during periods of extra low tides and camped on during neap tides. To the Kaiadilt they seem to be places much like those on more permanent soil and equally worthy of names. The low and unsubstantial nature of the islands also has led to physiographic changes and some places now only reefs are remembered in tradition as once land, hinting that occupation of the island has continued uninterruptedly for generations.

The map embraces the whole of the territory visited by the Kaiadilt people of Bentinck Island and until the time of the arrest of the Allen Island people in 1941 and the first visit to Mornington Island Mission by the 1945 party no person of the tribe had, within living memory been elsewhere and returned to relate his story. Although they were familiar with smoke fires of places below the horizon in most directions from their island, two places outside their area were most readily visible to them, one the long line of low mainland shore visible on the southern horizon, and the outline of Sydney Island visible to the north, but only from the tops of high sandhills at Berumoi. This, the only part of the Mornington Island area visible is called Olkadil [O:lkadil]. When we stood on the crest of Berumoi, Olkadil was a hazy smudge on the horizon. It is to be noticed that this name, as Olkadiil ['Olkadi:l, 'Olkadi:lt] is applied also to a camping place on the south coast of Bentinck Island.

Mornington Islanders, who likewise can see only one place on Bentinck Island, the Berumoi sandhills, call the island Maldanunda. Formerly they knew of the existence of other places only from the rising smokes of fires which periodically appeared over the horizon. They had interpretations of the activities of Bentinck Islanders on various outer islands based on "readings" of these smokes.

NATIVE TRADITIONS OF CONTACTS

One aged Lardiil woman said that there was an olden time story which said that Allen Island people came from the vicinity of Burketown at a time when men were shooting natives along the Leichhardt River. She claimed that the language of Burketown was a little like that of the Kaiadilt. This story could not be confirmed except in the reference to the coming of mainland people to Allen Island where they fought with the Kaiadilt in "ancient time".

Bentinck Islanders are also said to have once or twice come to Mornington Island, but the Kaiadilt themselves have no tradition of such a contact.

In view of the unusual set of the South East trade winds at the time of turtle hunting and egg gathering, in the later half of the S.E. Trade period, when Bentinck Island men become venturesome in visiting the outer reefs and sand banks, it might appear that Bentinck Islanders have on occasion been driven on their rafts to Mornington Island, but they may not have lived to reach home again. The genealogies mention several men who disappeared on raft voyages and never returned.

The impression is gained that the Kaiadilt have remained an isolated people for many years and this is confirmed by the absence of any sign of the 4 and 8 class systems of social organization of adjoining peoples and the relative isolation of their language, which, save for Janggal, the tongue of the Forsyth Islanders, to the north-west, appears not to be very closely related to any neighbouring language.

CLIMATE

In the absence of direct records of rainfall and temperature it is difficult to provide exact criteria to indicate the climate of Bentinck Island. For the purposes of this paper the likely general rainfall was estimated by taking available readings between 1910 and 1956 from the several nearest recording stations of Normanton, Augustus Downs, Karumba, Mornington and Burketown, all within a radius of 100 miles of Bentinck Island, so far as they were available, and computing an annual figure, which over the years between 1910 and 1956 yielded an average of 33 inches. Inclusion of the Augustus Downs records may have lowered the average unduly, but the results suggest rainfall in the general vicinity of 33 inches. This agrees with the trends of the isohyets shown on the Annual Average Isohyetal Map of Queensland, published by the Bureau of Meteorology in 1940.

Rain generally falls in the summer. Aboriginals tell us that in occasional years when heavy rain falls in winter or when there is much fog and drizzle at that season of the year they suffer from exposure. These are the "bad years" when people die of cold and sickness. At such times sea fogs may trap them at night on the outer reefs where they may be in danger of drowning because of loss of their bearings. Summer or winter the prevalence of low tides at night compels them to find much of their food in the dark of night or by the available light of the moon. Winters of dry weather without fog are "good years" and are considered more usual than wet ones. This is supported by the available records of meteorological stations in the vicinity. Bentinck Island is a little further south than Mornington Island and the climate probably is less maritime in character as well as being drier by ten inches or more, although basic similarities in vegetation indicate the differences in climate may be not very great.

In the climatic classification of Thornthwaite (1933) the Bentinck Island group would fall into the type CA w, *i.e.*, subhumid tropical with deficient rainfall in winter. In the system of Köppen (1931, 1936) the area lies near the junction between V Shw and Awi, *i.e.*, between a "semi arid climate with annual average temperature over 18°C., with winter drought, with at least ten times as much rain in the wettest summer month as in the driest winter month", and "tropical summer climate with distinctly dry season in low sun period or winter, and range of temperature between warmest and coldest months of less than 5°C." The last-named classification suggests that Bentinck Island occupies an intermediate position. It has a marine climate but it is situated nearer the dry mainland and is not so greatly influenced by its setting as is Mornington Island, which lies deeper in the Gulf and has an added 10 inches of annual rainfall. Bentinck Island lacks gallery forest trees save for a few relict strips in scattered places, where the ground water is near the surface, where it is augmented by small streams, or where the soil is a little more fertile.

As is characteristic of savannah lands, there is a complete reversal of normal wind direction between the wet N.W. summer and the dry S.E. winter season which lasts from about May to November. Being situated near the drier boundary for savannah, tall grass predominates over patches of sparse deciduous woodland. While aborigines were present these open areas with *Themeda* grass, etc., which grew to heights of four to six feet after rain, were fired each year. In the 12 years since their departure this burning had only happened once, about May, 1959, when a party of Bentinck Islanders taken across on a brief holiday visit set fire to a large area on the south-eastern coast, thus in one area restoring a semblance to the conditions they had maintained for many centuries.

DESCRIPTIONS OF AREAS VISITED OR NOTICED

In the following section general descriptions will be given of the areas of Bentinck Island visited by our party in May 1960, or noticed in passing. More detailed notes on the vegetation will be possible when the botanical collections made are identified.

Western End of Bentinck Island

The first camp was made by our party on 23rd May 1960 at Minakuri ['Minakuri], the west-most point of Bentinck Island, our launch being anchored in 2½ fathoms off the point. There is a shelving sandy beach backed by a higher belt of sand. This is the north-most and physiographically youngest of a series of similar shore line ridges which have developed in the shelter of the mangrove fronted shore which here runs in an east-and-westerly direction. Inland from this youngest shore are the successively older parallel strandlines, the whole forming a series of low ridges and swales in a belt half a mile wide. All the swales are below ten feet above present high water of sea level but the ridges are higher. The series has been truncated at the western end by seas sweeping through the channel between Dalwai (Albinia Island) and Minakuri. The north-most of these sand dune ridges and swales is entirely of loose sand but ones further south become progressively more indurated near the surface, probably by percolation of rain water and transfer of lime. At Miant ['Miant] the upper part of the developing sand rock has become truly consolidated. Where the less hardened layers under it have been undermined by the sea, these upper layers collapse into large slabs of soft limestone rock. At Miant itself there is a spring which flows into the sea at low tide from seepings at tide margin. The water forms a small pool frequented by various species of birds, whose scratchings seem to keep the water supply open and the paddlings of their feet help in forming a slight pool. This water seems to be escaping from the dome of fresh water held between the parallel dunes and swales of this dune series. It is considered by aborigines to be a never failing supply. It was however affected by salt water during the tidal wave of February 1948, which according to native eyewitnesses, covered all but the tops of the higher dune ridges with sea water, working inland for at least a mile along the swales and killing all trees except those on high sand ridges and on some land-locked marshy land with *Pandanus* palms, situated about half a mile inland.

Just south of Miant the beach rock is being extensively eroded by the sea and undermined in great flat slabs. Aborigines pointed to what are now rather indeterminate marks in the indurated sand crust, some fifty yards south of Miant, and claimed they were actual footprints of former aborigines, not artifacts or rock carvings, but their actual tracks. The old man who showed them to us was rather disappointed when we could not see the marks very clearly and he blamed the sea which had, since he was a young man, partly destroyed the supposed tracks of his ancestors. Continuing south the beach ridges suddenly cease, the most southern lying on a broad sheet of clay forming a clay pan which further inland extends in a belt up to half a mile wide for a distance of several miles in an easterly direction. Following the coast line south the eroded outcrop of this clay pan, trimmed by the sea to low tide level, is marked at Ngolorngolor [ˈŊolorˈŋolor] by a fringing growth of mangroves. These extend with small breaks along the whole strip of claypan lined shore south to Tjodjongatjoro [ˈTjodjoŋaˈtjo:ro], a distance of one-and-a-third miles. The mangrove trees here are of a variety useful in poisoning fish, by using scrapings of the wood. There is a small, nearly circular area of seemingly older and slightly elevated deep soil-covered land some 200 yards across, with trees, at Monoko [ˈMonoko]. This is interpreted as a small remnant of land older than the parallel sand dunes perched on the clay pan, which itself seems to have been a sea floor of the Recent past. At Maltaruki [ˈMaltaruˈki:] there is a small mangrove-filled estuary where rain water from the claypan escapes to the sea. Walking inland at Monoko and following the margin of the dune system eastward it is evident that what is now the inland side of the dunes has suffered some deflation and partial destruction from streams of rain water such as flow off in the wet season. These have worked back into the range system cutting channels down to the level of the claypan. At favourable points where the clay is depressed, possibly by compression under former weight of sand, there are marshes, some of freshwater plants, others of salt meadow type. Thus Kirkamangkatanapa (napa = ngapa, means water), is rather brackish and unpleasant to taste, though used; Orandji ['Orandji] has good water, slightly sweet to the taste, it was a local mainstay for water; Mankange ['Mankan'ge] also has water, quite fresh, the marshy soil here is so free of salt that a liliaceous plant related to *Xerotes*, the fibre of which is used for string-making, grows very luxuriously.

The surface of the claypan sets hard when dry but carries impressions an inch or more deep. Today these are principally of the tracks of Native Companions, the only large walking inhabitants, other than jabiru and Varanid lizards, which today frequent the island. The claypans were native "roads" which aborigines followed when travelling quickly from one place to another. Near older land surfaces the erosion of lateritic soils has provided a layer of black-stained ironstone nodules which covers the surface of the hardpan; on the divide between claypan water flowing west to the sea and that flowing north-east to the river channel at Tungalakar ['Tuŋalakar], there is an accumulation of wind blown dust and silt caught by vegetation in the marshy ground. Near Orandji this forms some grassland, and a mixed marshy meadow is growing on the veneer of soil over the clay.

Inland from the claypan and forming a central ridge running in an arc roughly from the south-west from the coast at Walkareri ['Walkare:ri], veering eastward and extending for several miles, is a plateau of higher and older land, breached in several places by cross-cut channels, revealing claypan bottoms. Viewed from the sea to the north this plateau rises in a whaleback to Mambungi ['Mambuŋgi], and forms the highest land area to be seen in the south-western portion of the island.

On the ground Mambungi is seen to be the surviving remnant of a peneplaned older land surface levelled off by the sea at heights up to 33 feet above high tide mark and forming a plateau remnant so locally flat on top that the surface of the laterite soil is marshy and waterlogged and carries a thick growth of *Melaleuca* and broad-leafed *Eucalyptus*. The south-western face of the cliff-like edge of the laterite plateau of Mambungi is dry and is clothed in porcupine grass

(*Triodia*) giving an impression of arid dryness such as would not be amiss through much of inland arid Australia, even though just a few yards away on the laterite plateau above the seemingly water-logged laterite soil supports *Melaleuca*. The margins of this plateau have been notched by the sea and cut back so relatively recently that rills of water which run off the surface of the plateau have not yet had time to cut more than incipient gorge-like channels here and there into the margins of the plateau area. In large measure this remains intact in the shape its cliff-like margins were fashioned by seas cutting at its foot. The feet of the cliffs now are situated by measurement some ten feet above high tide mark. The marshy surface of the plateau is held up by a heavy duricrust of lateritic ironstone overlying a considerable thickness of clay of gumbo-like consistency containing ironstone nodules.

A rough dumpy-level survey line was run from Mambungi to the sea at Kapilauru ['Kapilau:ru], a distance of two-thirds of a mile in an S.E. to N.W. direction. The result is shown in the top half of fig. 1. The survey was achieved under difficulties and cannot be relied on to be more accurate than to the nearest foot but it may give a useful indication of some aspects of the physiography of this part of the island.

The drawn section indicates the presence at its N.W. extremity of a mangrove-fringe at Kapilauru. This extends out to sea from high tide mark on a mud flat for more than one hundred yards. The point selected as datum was at the margin between that part of the beach which carried vegetation and that kept free of growth by the rise of water at high tide behind the shelter of the dense belt of mangroves. This is considered to be normal high tide mark. The clay of this mangrove flat, at a point a little further west, was observed to overlie a reef of hard ironstone laterite with some shelly limestone. At Minakuri, to the west, during our stay, we found that in the channel the tide dropped at least ten feet during the night, since the launch which drew three feet and was anchored in well over 2 fathoms, touched bottom at lowest ebb.

Following the section inland from Kapilauru there is a dune of sand, here high enough to carry an open savannah of broad-leafed trees of types commonly found elsewhere in impoverished coastal and riverine jungle. Where the section was run the dune rose to nearly 20 feet, with a swale in which the soil appeared to be richer and carried a dense growth of vines, including a native passion fruit and several species of native yam vine. These have not yet been identified

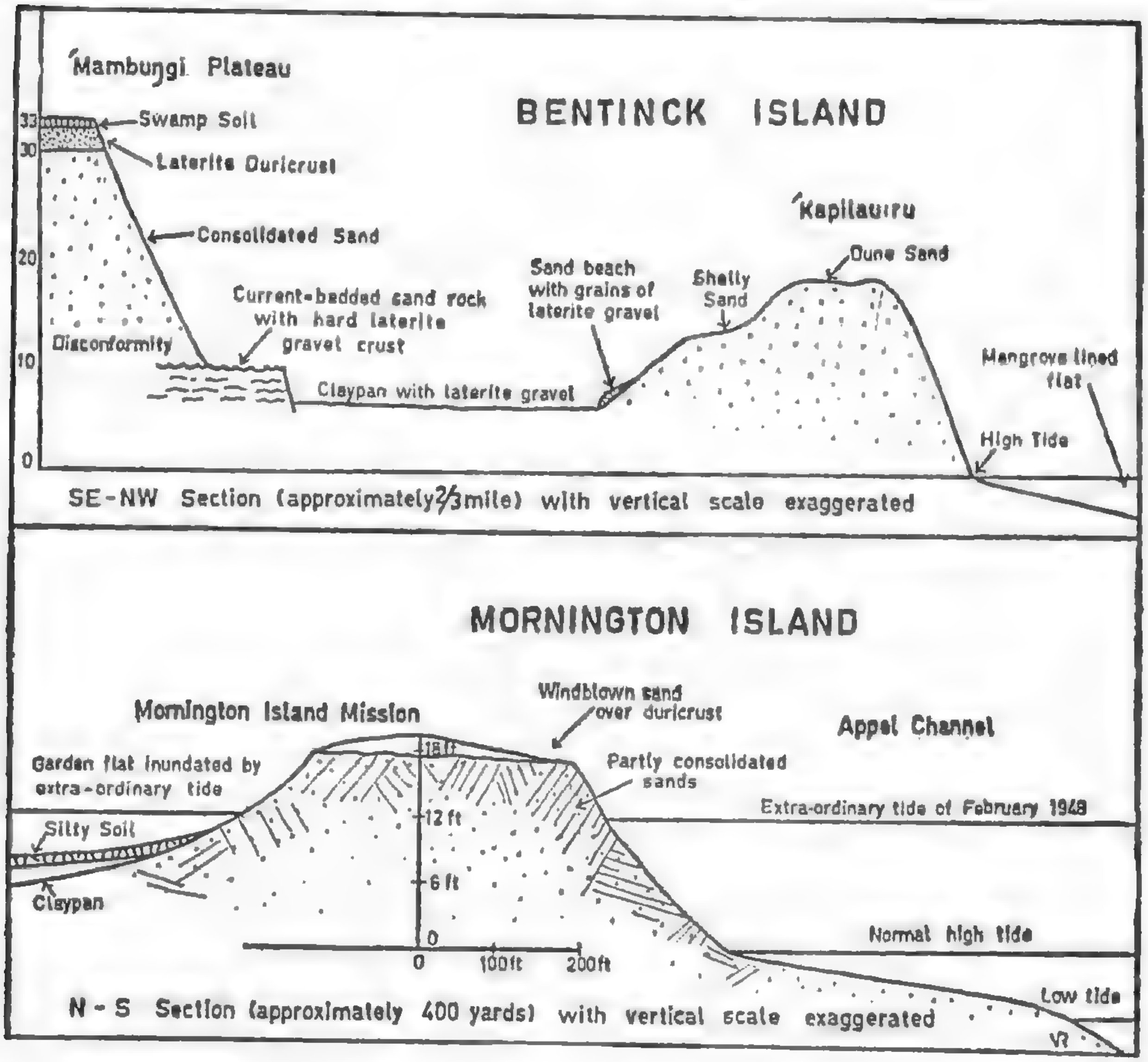

Fig. 1. Coastal elevations at Kapilauru, Bentinck Island (upper section) and at Mission Jetty, Appel Channel, Mornington Island (lower section).

because, at this season of the year, they were not in flower. They yielded tubers in abundance for the aborigines in our party. The seaward face of this dune had been cut and notched by storm seas of the N.W. season. On the inland side there was a beach-like ledge and also evidences of an older terrace notch at from 12 to 15 feet above present high tide mark. This showed a shelly sand which had been wave-sorted. The dune belt was about four hundred yards wide, the inland side dropping down to a claypan margined with a low sand beach at 6 to 8 feet above sea level. The sand of this beach contained an abundance of laterite sand and gravel. It appeared to be a beach formed when the claypan itself was inundated. The surface of the claypan stands at six feet above present high tide mark, and at this season its surface locally was flat, dry, and strewn with laterite gravel. Evidence of recent wet season flooding by rain water to a maximum depth of two feet was apparent. This water had been lapping against an outcrop of current-bedded sand rock with a hard laterite gravel crust which formed a low cliff at the south-eastern shore of the claypan at this point. It was apparent that this hard outcrop was overlain disconformably by the consolidated sand, tenacious clay and laterite duricrust forming the Mambungi plateau. This plateau, as indicated above, gave evidence that it had been attacked laterally by the sea at some former time. Its relatively steep walls were breached here and there by short trenches or valleys which ran back into its mass for distances of up to fifty yards usually ending in a lip of duricrust over which, in the wet season, water had flowed. The plateau itself, at the locally highest point, was 33 feet above our high tide mark. The uppermost foot was of waterlogged soil in which there was water even at the end of May in the S.E. Trade season; it carried a dense growth of undershrubs, broad-leafed Eucalypts and *Melaleuca*.

This section is described in detail because the data it provides is of considerable help in the interpretation of the structure of other parts of Bentinck Island which we saw, and assists in an appreciation of the effects of a flooding of the island by the sea in 1948, as described in later paragraphs.

Northern Extremity of Bentinck Island

The *dolnoro* area denoted as S on the accompanying map, was visited in company with its *dolnorodangka*. After sailing along the westerncoast on the crest of the high early morning tide at a short distance from the shore, the Markaruki ['Markaruki] estuary with its broad areas of mangrove forests covering half a square mile of mud was clearly visible from the north; a quarter-mile wide belt of normally dry claypan and sand lies behind the mangrove fringe. Inland is a wooded plateau seen by us only from a distance but estimated to be rather similar in elevation and general appearance to the Mambungi area examined in the south-west. A smaller estuary at Naltalk ['Naltalk] lies within a mile of the northern point of the island, cutting through a northern extension of the plateau and joining the sea on the western shore. The north-western end of this plateau, where examined near Molatjikara ['Molatjikara], in part had been planed off at sea level to form reefs exposed at low tide. Boulder detritus from this reef as also other hard rock on the eastern side of the point had been built into fish trap walls, most of those on the western side had been damaged by wave action. The north-most point of the island itself is a low flat area chiefly covered in *Themeda* grasses, *Pandanus* palms with a few sheoak trees (*Casuarina*) on the beach. There is a soakage well near tide mark, beside some *Casuarina* trees responsible for the native name of Lokoti ['Lokoti, 'Rokoti]. The point continues north out to sea as a sand spit. Twenty yards inland from the northern beach line is a shallow depression, Ritjuro ['Ritjuro] where fresh water was obtained by digging at a shallow depth. The grass here is principally *Imperata*. On the eastern side of the point is a high, well grassed sand dune system of which the highest parts are probably of about 100 feet elevation. These relatively fixed dunes extend south-south-eastward in a belt a quarter-mile wide for two or more miles, but diminish in height towards the south. The dunes collectively are known as Berumoi ['Berumo:i] which is also the specific name of a point close to where the inland estuary of Naltalk impinges on the dunes. The dune system appears to be of long standing and scattered groves of *Macrozamia* or burrawang palm are present amid *Themeda* grass, together with broad-leafed shrubs like *Tilia*, and vines, with patches of *Pandanus* and of *Imperata* grass in the hollows. The north-eastern part of the point is formed, at Bandaro ['Bandaro:], by a hard rock reef extending out into the sea and joined to the Berumoi sandhills by a boulder beach, and by many large blocks of stone at Mariwupanda ['Mariwu'panda]; this name literally means "*mariwu* rocks", it is the place where indurated siliceous rock is obtained for their stone oyster picks, knife flakes and palaeolithic type biface choppers (*mariwu*). This rocky outcrop is a particularly important native possession because of the presence of this rare island resource. Between Bandaro and the place called Modorokolaijarup are several large stone-walled fish traps, still in tolerable order, fashioned from the freely available boulders. All the walls are heavily encrusted with oysters. Several large fish, called *burantant* ['burantant] and *karwark* ['karwark], were speared while we were there, having been trapped at half tide within the walls of the enclosures. Fresh water is obtained by digging among the boulders and into a yellow clay at tide mark, under Berumoi. The clay is said to be the dung of a Being named Katjuruku, which some now say, since seeing dogs at Mornington Island, was a Dog Being, although they have no word for this animal in their own language and have to call it simply *doga* ['doga].

Descriptions by others of the Being, who is associated also with Sweers Island and with a supposed cave on the Markaruki River, suggest that Katjuruku may have been a person or persons from a visiting ship. This ship may have sailed along the coast and entered estuaries at Markaruki and Waduri before journeying to the northern point of Sweers Island.

South-Eastern Point of Bentinck Island

Our second camp was at Njinjilki ['Njinjilki] three-quarters of a mile west of the south-eastern point of Bentinck Island. The launch could be anchored here in four fathoms close to shore in a position sheltered from most winds because of the short fetch from Sweers and Fowler Islands. Sandstone outcrops on the beach and has been notched by the sea. Fresh water oozes from the rock as tiny springs, encouraging a line of *Casuarina* trees which mark the native camping place. A hundred yards inland is a lake of fresh water, about one-quarter of a mile long and of variable width, margined by large *Melaleuca* trees and carrying a relatively dense but narrow growth of fringe-jungle along its shores; this is the most fertile looking strip seen on the island. It presumably is the fresh water lake mentioned by Flinders. On the high bank separating the lake from the south coast are growing the largest *Eucalyptus* trees seen on the island together with *Pandanus*, and tall *Themeda* grass, *Imperata* grass appears in hollows, and in the lake itself magnificent growths of waterlilies (*Nymphaea*), indicate the relative permanence of the water. Immediately west of Njinjilki is a shallow bay margined by a cliff whose plateau top is within a foot or so of 30 feet above high water mark and densely clothed in low heathy vegetation growing on lateritic ironstone. Inland and west of here is a broad area of clay-pan representing the innermost parts of a large drainage basin breaking through an old dune system, now heavily vegetated, on to a broader clay pan and estuary, filled with a dense growth of mangroves and opening on to the eastern coast at Rutaruntaro ['Rutaruntaro]. This 'river' is called Birpakari ['Birpa'kari] by the former inhabitants. The easternmost point of the island, Karukai ['Karu'ka:i, 'Karukar] is the Raft Point of Stokes, and the reefs off the point are the supposed place where Roth's party, in 1901 secured photographs of their contact with the Kaiadilt, for example pl. 8, fig. 1 and 2. *Pandanus* palms grow nearly to the tip of the peninsula.

The cliffs west of Njinjilki previously referred to, show a thirty foot section to sea level. The top layer is composed of fifteen feet or ironstone laterite, below which there is a soil horizon of about one foot resting on yellow sand, rather firmly consolidated and of variable thickness (9 to 11 feet) itself lying directly on a red and gray mottled sand rock which extends to below tide mark; in front of the cliff this rock has been planed off by the sea to form a broad shelf lying below high tide level. The cliff had been attacked previously by the sea at a height not much different to its present level of attack. As evidence of this, at the eastern end of the bay a series of cross-bedded sands, apparently wind-laid, and now consolidated had been lodged against a fossil portion of the cliff. These consolidated sands are now being attacked by the sea along with the laterite cliff face.

Viewed from the sea it seems evident that the high ground at Njinjilki at some time has been planed off by the sea at the same general level of about 30 to 35 feet as has Mambungi plateau at the western end of the island.

Across a mile wide strait from Njinjilki is Baltae, the small island named Fowler Island by Stokes. It is known to Mornington Islanders as Hall Island, after their pioneer missionary who was killed on Mornington Island in October 1917; Hall once sheltered off it on a voyage to Mornington Island.

Sometimes the native name is heard as [ˈBatae] and again as [ˈBa:tai] but the oldest woman now living, whose birth place it was, prefers [ˈBaltae]. Baltae is applied to the whole island, but there is also a specific place of this name inside the forest of black mangroves at the southern end of the island.

In tradition the island is associated with a Being, Ngalkadaruru [ˈŊalkadaru:ru] who had the power to cause strong south-easterly winds to blow. This creature, was perhaps the same Being as one vaguely remembered to have dug a well in the centre of the island and obtained water there. "He broke the water out of the high ground." This well is said to be there still, but details of the story were not obtainable and time did not permit a visit to the site.

Interior of Bentinck Island

The central part of the island was not visited and the data observed near the three extremities of the island has had to be eked out by inspection of aerial photographs. Thus the results of our observations on the geography of the interior of the island as a whole are to some degree tentative and remain so until opportunities occur for further study.

Sweers Island

This island lies south-east of the main Bentinck Island mass. At its south-eastern end is the high point, Inspection Hill. On the eastern cliff slope of this hill, at Durakara, a section was studied. It shows mottled red and white clayey sand rock with shells extending from below sea level to 5 feet above high tide mark overlain by partly consolidated laterite soils to thirty feet above sea level, over which is some 70 or more feet of marine coralline limestone, much eroded, and weathered into rough masses almost impossible to climb over. The area of land over 30 feet above sea level on Sweers Island runs north and south for not more than one mile by one-third of a mile and has an abrupt cliff facing the east. There is a further plateau area of about half a square mile, 30 to 50 feet high, with a cliff on the west estimated to be from 25 to 40 feet high near Dalkuruki ['Dalkuruki] on the northern third of the island. This is covered with a rather dense stand of a white-barked species of Eucalypt. The native name of the forested area is Ngankudalaijarup ['ŋaŋkudalaijarup]. The northern extremity, with cliffs on the eastern side, is a plateau no more than about 30 feet high. All the rest of the island is low, covered in small open scrub of *Eucalyptus* and *Acacia* with tall grasses. The northern and southern extremities of the island were once almost divided from each other save for a slender tombola-like strip which became widened by accretion of lines of parallel sand dunes; these run NNE-SSW along the eastern coast. There are some fifteen dunes and vegetated swales in a belt a third of a mile wide. The full complement is present near the sheltered southern end of the series near Ordodurui ['Ordodu'rui]. North of Kidiralangi ['Kidiralaŋgi] subsequent erosion has cut very obliquely through those nearest the coast and only some ten dunes remain. A similar series, of about ten dunes, run east and west from Milt (Point Inscription) to Dangalo ['Daŋa'lo:] also in a belt about 500 yards wide. These evidences of the late history of the island are in line with those on Bentinck Island itself. It is suggested they are all the results of events of Post-10ft. Terrace time.

The Western Islets

Northwestmost of the several small islands off Bentinck Island is Ngataiwind ['ŋatai:wind] or Douglas Island. It is only a few feet above sea level and covered with low shrubs including a species of native currant bush. Tracks of a recent visit, assumed to be by Bentinck Islanders, were seen on the island by Mornington Island

Mission men who landed there on 10th August, 1946. It is said to have been visited very seldom by them.

Kandingarupai, the Bessie Island of Mission records, was visited more often by natives on rafts. It has no reliable water supplies; shell dishes of water had to be taken there. It was an attractive place for turtles and their eggs, hence was a tempting, if dangerous place to visit.

South by east of it is Dorati (the Margaret or McCarthy Island of different Mission records). This also is low, divided into two at highest tides, and waterless, except immediately after rain. It was always necessary to carry shell dishes full of water on the rafts when attempting visits there. The journey was considered hazardous and only to be attempted in very calm weather but the lure of turtle meat and eggs was important enough for risks to be taken. Formerly it was larger and according to Kaiadilt tradition, included an area now cut down to below sea level as a sand bank, named Ngindalki ['ŋindalki]. This bank extends south by east towards the main island.

These outer islands and reefs were not specifically within the territory of any one *dolnoro* although the people who were said most often to venture there were those of the group denoted herein as *dolnoro* X.

Nearer to and north of Dalwai (the Albinia Island of Mission records), is a large reef exposed at lowest tides. This was an important food gathering area called Meranmarai ['Meranma'rai]. Dalwai itself was often used as a camping area by members of several western *dolnoro,* more particularly when they were at enmity with eastern *dolnorodangka.* Several of the brief missionary contacts with Bentinck Islanders in 1945 were at Dalwai; at such times eastern men stayed at Minakuri until they could be assured of the intentions of the white men. Several very dramatically described encounters by McCarthy with Bentinck Island people, recorded in his diaries and Mission reports, took place at camps near Morokonobai ['Morokono'bai].

Allen Island was known as Ngarkenap ['ŋa:ke:nap] and also as Dalenduru ['Dalen'duru], but the last named may really be the Janggal tribe term for it. It was visited by the people of the south-western *dolnoro* of Bentinck Islanders but until the last generation of occupation of the area no people ever were known to have received *-ngati* names, from having been born there. It was a kind of no-mans-land where occasionally people of the Janggal tribe from the adjoining mainland and from Forsyth Island paid visits, and according to tradition, occasionally fought with the Kaiadilt. Within living memory they had not had any friendly contacts. At the north-west end of the island is Ngandamuro ['Ŋandamuro] the long reef and sandbank which in 1802 prevented Flinders from circumnavigating the island. The north-western tip is Taliwinduru ['Taliwinduru]. Two girl children born in 1940 bear this as their *-nguli* name. There is water in springs emerging among the mangroves. It was here that the Minakuri people in late 1940 murdered "Cripple Jack" of Mornington Island. The north coast is mangrove-lined on the northern half. The first break is Munuku ['Mun:uku]. Just south of this is the mouth of a small creek linked to an inland system of swamps. One of these is a waterlily lagoon named Ngarkinabai ['Ŋarkinabai] the only lagoon on the island. The island generally is a low plateau, well wooded, with trees of a type called *korokari* by the aborigines (not identified), "milkwood" trees and white gum trees. The south-eastern tip is Modomodor ['Modomodor] where there is a native spring, called a *koangoko* ['koaŋoko], on the beach, accessible only at low tide. On the south-eastern coast, in the second bay from the southern point is Ngandamurur ['Ŋandamurur] where another spring of water emerges on the beach. Still further north in the third bay a spring, Wandaruki ['Wandaruki] flows across the beach, and a fourth spring is to be found at Kalturi ['Kalturi:] about a mile from the north-west point. All these sources of water fail in dry years, rendering the island untenable as a permanent home.

To the north-east of Allen Island is Didjer ['Didje:r] or Horseshoe Island, a half circle of mangroves embraced by a sandy bank and a reef where Flinders encountered his aborigines. From the old man's vehement speech during the meeting Flinders recorded a single word, *jahree*.

In the present day Kaiadilt ['jari] is a verb in the imperative meaning "Go!" A native story associated with a Being called Barindindi ['Barindindi] has its setting on Allen Island or vicinity. In this story Koreanu ['Koreanu] was holding a fish he had caught with his hands in the mangroves. He went down to the waters edge as Barindindi came to the shore. "Why do you come up here?" Koreanu held the stranger with spears, and told him to "go away" ['dalitj]. The verb used is a stronger one than ['jari].

It is possible to regard this as a local counterpart to the record of the same encounter made by Flinders in his journal.

A version of it appears on a tape record by a middle-aged woman named Morokonobaingati walawa; it was made during discussions on another strange Being, Katjurnku, referred to in an earlier paragraph.

In the preceding sections of this paper an attempt has been made to introduce the geographical setting in which the Bentinck Island people lived until 1948.

As a result of a series of disasters they suffered a severe reduction in numbers after 1945 and by 1948 were compelled to abandon their island. The final blow which rendered useless the country which had sustained them for centuries, was the tidal wave of February 1948, data on which forms the final section of this paper.

THE TIDAL WAVE OF FEBRUARY 1948

One of the geographical objectives of the visit to Bentinck Island was an attempt to assess the effects of the phenomenal tide which occurred in the Gulf of Carpentaria during February 1948. This was one of the stated causes of the ultimate stress which led to the death of many Bentinck Islanders and indirectly resulted in the abandonment of their island home by the Kaiadilt.

The aborigines themselves describe the flood tide as having covered all but the highest parts of Bentinck Island. It deeply drowned most of the places where they were accustomed to live, and where they obtained their supplies of water. It caused wells and springs to go salty. They were not prepared for the flood and suffered thirst even while the tide was at its extraordinary height. Their many subsequent efforts to find sufficient water by digging out wells and pot holes along the beaches and, later in the season, water-bearing frogs from out of the dried up bottoms of swamps, have been described to me and were noticed by McCarthy in his report describing conditions in October 1948, when he went to rescue the last of the islanders from the south coast.

The principal data on this extraordinary tide is recorded in an official report made by Gloe and Weller (1949) to the Queensland Irrigation and Water Supply Commission. This Department had been asked to advise on the rehabilitation of the garden area at Mornington Island Mission which had been destroyed by this tide. The tide was stated to be without recent parallel. The actual date and time of the flood tide unfortunately is not anywhere cited. Gloe and his companion prepared a map of the Mornington Island Mission area on which they placed approximately the line of encroachment by this tide but made no mention of the height of the rise. During our visit it was possible, on 14 May 1960, to survey a line from high water mark in the vicinity of Mornington Island jetty to the garden flat (see fig. 1 bottom half) and from physical effects still visible, to ascertain that the rise was to twelve feet above the highest normal tide mark. The last named is indicated by the growth of vegetation at the foot of the half-consolidated sand dune on which the Mission headquarters is placed.

At Mornington Island the flood caused large *Eucalypts* to die and had caused a change in areas flooded by the salt water from its former savannah and tree growth to a salt loving vegetation; only *Melaleuca* and *Pandanus* growing near to the edge of the flooded area had survived, and there was evidence that much of the coastal vegetation other than mangroves and *Melaleuca*, in the parts inundated, had been killed. New growth had developed only after the salt impregnations had been leached away.

With this data in hand and the types of injury to vegetation it had caused at Mornington Island before us, it was possible to assess that the sea had risen at least to the same extent of about 12 feet above normal tide on Bentinck Island. It flooded all but the higher parts of the island; the indications confirm aboriginal statements that it divided the main island into two by inundation of the clay pans which extend from the north-west coast at Markaruki to the south coast at Kombali. As much as 50 per cent of the land area of Bentinck Island temporarily must have been covered by sea water, including the parts most intensively used by the people. The effect would have been temporarily to restore conditions as they might have been during the Ten foot Terrace sea level of Mid-Recent time. There is evidence around the island and on Mornington Island in the form of wave cut terraces at about this height above sea level to indicate the former presence of this eustatic sea level.

The vegetation other than mangroves and some swamp plants, was in large measure killed and even today such areas still principally are covered either with grasses, and salt marsh vegetation, or remain bare. At points which stand no more than a few feet above the twelve foot mark the trees survived, and these are the principal places which today remain clothed in savannah woodland.

It is probably correct to assume that 50 per cent, or possibly at most 60 per cent of the island was affected by the tidal wave in such a way as to be unproductive of its usual share of the islanders' terrestrial food, and water, during the balance of the time the aborigines remained on the island. There had been already a decline in population in 1947, from killings, drownings and the supposed effects of drought. The removal by McCarthy of the large party from Sweers Island, late in 1947 must have reduced the pressure on the remainder, but even so the final stresses were great.

Information on the population crash which terminated their stay on Bentinck Island, based on genealogical and other information, is the subject of a separate paper following this one. It assesses the various factors which contributed to this calamity, one which happened to a simple hunting people living their own life, apart from the modern world, and may serve as an example of a type of recurrent happening which must have played a part in the development of man.

ACKNOWLEDGMENTS

The author is indebted to the Wenner-Gren Foundation for Anthropological Research for a grant in aid for a study of the Bentinck Islanders. The Board of the South Australian Museum supported the field work. It is a pleasure to acknowledge the ready co-operation received from the Rev. J. R. Sweet and the Presbyterian Church Committee, Brisbane, and to recall the direct help received from the Superintendent of the Mornington Island Mission, the Rev. D. L. Belcher. He, Mrs. Belcher and all members of the staff at Mornington could not have been more kind. Mr. Peter Aitken, Assistant Entomologist at the South Australian Museum was companion on the visit and provided unstinting aid.

For permission to use some photographs, and much other help I am indebted to Rev. Andrew R. Wilson who obtained historical data from others, including Rev. W. F. MacKenzie, Mrs. M. Burnett, Rev. C. D. Sydney and also from his mother, Mrs. R. H. Wilson, to all of whom I owe thanks.

Mr. C. Claxton of the Land Administration Commission, Brisbane kindly provided data about early leases on Sweers Island. Dr. J. A. Spalding furnished a copy of his Medical Report of 1947. Mr. R. C. Sharman, Queensland Government Archivist, supplied references. I am indebted also to the Mitchell Library, Sydney for access to several original documents. Mr. Vincent Roth, Curator of the British Guiana Museum kindly searched through his father's surviving papers but was unable to find anything relevant to the present research. Messrs. R. E. Davies and P. McK. Kitchen, who photographed some Bentinck Islanders in 1945 at Mornington Island, while engaged as Air Force Officers on duty, kindly made their negatives and personal photographs available for study.

Gully Peters, the Mornington Islander, who with his wife Cora, has devoted the greater part of his adult life to trying to make contact with the Bentinck Islanders, and after twenty years of work, succeeded in bringing them into touch with the modern world, was our constant helper; without his aid the work would not have been possible.

The Kaiadilt patiently bore our incessant questionings and pryings into their former life, and twenty of them were happy to accompany our party back on a visit to their island, so providing the needed first hand data about its human geography.

Mr. H. Burrows kindly drew the accompanying map from a rough draft and Miss V. Richardson prepared the finished drawings of the Sections.

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DESCRIPTION OF PLATES

PLATE 8

Fig. 1. Two of Roth's party on edge of reef. The Kaiadilt man on the right is Kalturingati walta, as identified by his son. As an old man he was speared just before Minakuringati kulkitj fled to Allen Island in 1940. Mrs. R. H. Wilson's copy of this picture is labelled "Bentinck Island, June 1901". Photo: J. F. Bailey; original negative in South Australian Museum.

Fig. 2. Kaiadilt men on the edge of the reef; in the background one is holding up a mass of debris. Central figure is Tarukingati warungalta, as identified by his son. Photo: J. F. Bailey, June 1901.

PLATE 9

Fig. 1. R. H. Wilson and timid group of thirteen Bentinck Islanders at Baltae in late 1927, during their first voluntary contact with a white man.

Fig. 2. Mrs. R. H. Wilson and four Lardiil helpers standing behind a group of six women and ten Kaiadilt children during the second contact, late in 1927.

DESCRIPTION OF MAP A

Dulkawalnged or Bentinck Island showing *dolnoro* (hordes) and native place names of the Kaiadilt tribe.

To face page 296.]

SOME POPULATION CHANGES AMONG THE KAIADILT PEOPLE OF BENTINCK ISLAND, QUEENSLAND

By Norman B. Tindale, Curator of Anthropology and Acting Director, South Australian Museum

Summary

This paper records the rise, and decline of a small isolated population of Australian aborigines on Bentinck Island, Queensland. After two or more generations of steady and slow increase to a peak of 123 persons in 1942, five years of decline brought about by less favourable conditions reduced the population to 58. Some removed from outlying islands by official intervention were eventually restored to the community after it was transferred to Mornington Island following white contact in 1948. Thereafter from a minimal population of 71 in 1951 they have increased again to 80 persons in 1960. Data given enables observation of the course of this population change in a simple hunting or foraging community, not in contact with other peoples. Their experiences illustrate some of the forces moulding tribal populations of people at the Stone Age level of culture.

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Plates 10-11 and text fig. 1-2

CONTENTS

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The researches were supported by a grant from the Wenner Gren Foundation for Anthropological Research. Full acknowledgment is given to those who assisted the project at page 294 of this volume of the Museum Records.

A two-paged summary of the contents of this paper was published in the "Abstracts" of papers for the Tenth Pacific Science Congress held in Honolulu, August, 1961 (Tindale 1961).

INTRODUCTION

Bentinck Island is the centre of a small series of islands with an area of some 53 square miles situated in the southern curve of the Gulf of Carpentaria. It probably became an island group only when the Post-Glacial rise of sea-level flooded the Gulf. It had previously been a part of the Great Australian plain which extended across to New Guinea during the last cold phases of the Pleistocene and also during earlier cold phases of the Ice Age. Bentinck Island has varied in size. During the highest sea levels of Mid-Recent time (5000 B.P.) its total land area must have been reduced to close on one-half, as indicated by a shore line of eustatic type at approximately 10 feet above present sea level.

The Kaiadilt, a small tribe of dark Australian aboriginals, have occupied Bentinck Island for centuries. They were first known to exist when the explorer, Matthew Flinders, met six of them on an off-shore islet in 1802. Despite this early encounter the people avoided further close contacts with Westerners until 1948, although largely ineffective earlier efforts were made to meet them by Government officials, missionaries, and by would-be usurpers of their island. Between 1940 and 1948 there occurred a series of events which had drastic effects on the wellbeing of this people. The happenings included inter-hordal conflicts, accidental drownings by loss of small rafts during inter-island crossings, a long continued drought of serious effect, and finally an abnormal tide or tidal wave, in February 1948. This tide inundated the island for the greater part of a day, rising to about 12 feet above the highest normal tide mark. The water in effect reoccupied what is estimated to have been the maximum Post-Glacial shoreline, often in Australia called the "Ten Foot" Terrace.

Fairbridge (1958, 1960) suggests that this terrace may have been the result of two relative still stands of the seas, an earlier and longer phase which he calls the Older Peronian, and a shorter, the Newer Peronian Terrace. He dates the end of the second phase to about 3500 B.P. (1540 B.C.) and the earlier phase to near 5000 B.P. (3040 B.C.).

A previous paper in these Records, Tindale (1962), supplies details of the geographical and modern historical backgrounds for this study, and provides a map on which are shown the boundaries of the several divisions of the Kaiadilt tribe.

Genealogical studies detailed herein suggest that in 1940 there was a population of 119 persons, divided among eight *dolnoro* or territorially defined hordes. This population slowly increased from 103 persons present in 1910 to 123 persons in 1942.

Early in 1940 members, substantially of one *dolnoro* (horde-like unit), engaged in a quarrel and after fights with others, escaped to the outlying Allen Island, within their territory, but an area not permanently inhabited, because of the unreliable nature of its water supplies. They journeyed on rafts, losing three persons by drowning during the crossing of some eight miles of water which intervenes.

A native from Mornington Island Mission who landed on Allen Island from a dinghy, while on a mail-carrying journey to Burketown, was killed. Police rounded up and removed the survivors of the Bentinck Island horde to Aurukun, a Mission Station on the eastern side of the Gulf.

The remainder of the Bentinck Island population, now reduced to some 107, who were ignorant of the fate of their kinsfolk, remained out of contact with other peoples until 1945, excepting for an attack they made on personnel of a Royal Australian Air Force launch, anchored off Sweers Island during a gale, in 1943, when one Kaiadilt man was shot.

Rainfall records available from adjoining areas imply that there were years of reduced rainfall between 1942 and 1945. Water supplies normally are obtained from soaks and seepages at sea level. These derive from domes of fresh water trapped within the sands of the island following the heavy rains of the North-West Monsoon (December to March). Water itself is not remembered as presenting any special problem, but vegetable foods were stated to have been scarce and fishing was poor in 1945 and 1946.

Available rain records from surrounding areas suggest the summer rains generally were near to normal in 1946 and 1947 but on Bentinck Island there was severe famine.

In 1946 the culmination of several years of less than average rain brought stresses to a head. Inter-hordal friction was renewed; of 96 persons on the island at the beginning of 1946 only some 87 survived a year later.

In late 1946 or early 1947 fourteen of nineteen persons, predominantly of a second dolnoro, were drowned while going to Allen Island by raft. Those who escaped say they had hoped to obtain better food supplies; water then was not critically short. These five surviving persons were discovered by the missionaries at Mornington, to be on Allen Island, and were removed to Mornington Island. When found, they were in distress from shortages of water and probably would have died if they had not been rescued.

Of 58 persons who remained alive on Bentinck Island following the departure of these unsuccessful voyagers, a further sixteen died between early 1947 and mid-1948, after which, through the intervention of the Mission authorities on Mornington Island, all survivors were evacuated, the last leaving Bentinck Island in October.

Most of the deaths in the last year are attributed to effects of a culminating blow which struck this island population. This *coup de grâce* was a seemingly unprecedented high tide during February 1948. The coastal dunes were inundated and the sands flooded with sea water, rendering useless their normal water supplies. Frantic searches for water-bearing frogs, which pass the dry season buried in the dried muds of rainy season pools and ponds, marked the last days of the residence of the remaining Kaiadilt people on the island.

When brought together on Mornington Island there were only 83 persons representing the original 119 of the Kaiadilt population of 1940, including all those born in the intervening time and those held at Aurukun.

Several of those rescued from the stresses on Bentinck Island died from the effects of their experiences. The rest, who by 1951 numbered only 71, received careful medical treatment and their numbers then began to increase. They now live in a small endogamous community, an enclave within the territory of the Lardiil tribe, on Mornington Island, under the care of the Presbyterian Mission; those at Aurukun eventually were brought back into the group. Between 1951 and 1960, after the initial losses of weakened persons between 1948 and 1950, there has been a steady population increase from 71 to 80. When some further genealogical enquiries have been completed it will probably be possible to establish some ideas on the capacity for increase of the Kaiadilt people.

This paper thus records stages in a natural calamity which had the sudden effect of reducing a population to about 60 per cent of its former size. In fact this population presents us with the possibility of examining a small breeding group, maintained in isolation, subjected to abnormal climatic and other forces, of kinds which we may infer have occurred from time to time in the past. The happenings took place while living on Bentinck Island under natural conditions, without any buffering or direct intervention by Westerners during critical phases of their period of stress.

No detailed account of any similar sequence of events has been obtained. The facts therefore may be of some assistance in enabling researchers to visualize some of the kinds of events which have played a part in moulding the fate of early human populations.

There is a time limit on the situation, a maximum of 7,000 years since the islands were formed (Tindale 1962). There is the probability that, during the Climatic Optimum (Ten Foot Terrace) of Mid-Recent times (about 5000 B.P.), the island group was reduced effectively to no more than half its present size, probably with more than corresponding reduction in its carrying capacity. Its present area may not have been re-established permanently until some 3,500 years ago. The situation is likely to be most useful for several kinds of studies in microevolution. In this regard the blood grouping evidence reported by Simmons, Tindale, and Birdsell (1962, in press) is likely also to provide ample scope for theoretical discussion and thought.

POPULATION CONTROLS

Earl (1846, p. 251) was one of the first to give thought to population controls among Australians. A principle he enunciated for northern Australia was that "the amount of the population upon a certain tract of country, is great or small in proportion to the quantity of *vegetable* food it produces".

This principle may be sound for other than shore dwellers but where seafoods are available, as among the Kaiadilt it is not likely to be correct.

These "strand dwellers" so predominantly use the products of the sea in their diet, that it can be said that they are properly inhabitants of the littoral zone and only relatively casual visitors to real land. Among the Kaiadilt, women's work is tied closely to the actic zone (in its sense of the strip of half-land between high and low water marks). At low tide they gather tjilangind (small rock oysters), kulpanda (*Arca* mud cockles), and the denizens of mud holes and rock pools, retreating only at high tide to their camps under the sheoak trees just above tide mark (pl. 10, fig. 1) or to inland areas of land to dig for roots and stems of "edible" trees and vines, to catch grasshoppers for food and to glean the few varieties of seeds and fruits which the sandy dune and salt-marsh environments yield to them. Wood for fires, armsful of dry grass for camps, and plant fibres for ropes and string are the chief products of the land essential to their well-being.

Males explore the wider littoral, either walking up to their waists or chest in water or drifting over deeper reefs on their rafts of logs lashed together; at half tide either spearing fish trapped behind the walls of their stone fish traps or standing motionless for hours on the edge of outer reef channels waiting, in the hope of spearing a dugong, a turtle, or a shark. It is woman's work to repair fish trap walls and take the small fry among the fish trapped when the traps are almost dry. It is man's privilege to spear the larger fish cornered while the water is still deep.

The long list of totem names in the genealogies attached to this paper give a fair indication of the foods on which their main attention is focussed, incidentally drawing attention also to the sun, moon, rain, south-east wind, and waterspouts which control their lives, the rafts which carry them, the sheoak trees of the beach under whose half-shade their camps are placed, the crude palaeolithic fist axes, tjilanganda or mariwu, with which they open their oysters and "break" the wood for the poles of their rafts, paddles, and fighting clubs, and the baler shells for knives, with which they cut and scrape their spears and spearthrowers and the flesh of the marine animals that they kill.

POPULATION DENSITY

A map of the island appears in an earlier paper in this Journal (Tindale 1962), where the boundaries of the several hordes are shown.

The areas occupied by the eight *dolnoro* or hordes of the Kaiadilt people are also shown in the following table, which gives, in square miles, figures for the various types of country available to them. The areas were calculated indirectly, by cutting up a photographic copy of the map and weighing the several portions on a sensitive balance.

AREA OF THE BENTINCK ISLAND GROUP (in square miles)

	Total Area with Reefs	Total Area without Reefs	Land Area excluding Reefs and Interior Claypans	Area of Reefs	Area of Interior Claypans	Reef and Claypan
Dolnoro S	4·5	3·5	1·5	1·0	2·0	3·0
T	9·8	9·0	7·8	0·8	1·2	2·0
U	9·6	7·3	6·5	2·3	0·8	3·1
V	11·3	9·4	5·2	1·9	4·2	6·1
includes Baltae Island						
W	5·0	3·0	1·5	2·0	1·5	3·5
X..............	3·8	2·0	1·2	1·8	0·8	2·6
includes Dalwaii Island						
Y	5·8	5·3	4·3	0·5	1·0	1·5
Z	7·0	5·0	1·2	2·0	3·8	5·8
Totals Bentinck Island..	56·8	44·5	29·2	12·3	15·3	27·6
Sweers Island	5·8	4·2	3·9	1·6	0·3	1·9
Allen Island	4·8	2·8	2·6	2·0	0·2	2·2
Horseshoe Island	0·8	0·2	0·2	0·6	—	0·6
All others	1·8	0·9	0·9	0·9	—	0·9
Totals other Islands	13·2	8·1	7·6	5·1	0·5	5·6
Totals all Islands	70·0	52·6	36·8	17·4	15·8	33·2

From these calculations it is apparent that the total area of the islands, including their littoral, is about 70 square miles of which some 53 square miles are land. There are large areas of interior claypan covering 30 per cent of this land surface. Areas of littoral comprise approximately 25 per cent of the island area. As indicated elsewhere in this paper this was the most important part of their territory.

At first sight there seems to be little direct relationship between total-areas of-land or land-plus-reef, and population. If we compare the figures for 1940 when the area was being used at about greatest pressure, just as the intensified interhordal fighting broke out, foreshadowing the collapse of their regime, we see many difficulties in interpreting land use among them directly in terms of persons per square mile.

A Kaiadilt man gave us one clue. Dolnoro S, U, and X people have reef areas which they can work throughout both the N.W. and S.E. trade wind seasons, their N.W. season fish traps, etc., being built on the lee side, and so protected, and the rest protected during the opposite season. Some other hordes-people can only be sure of fish supplies for about one half of the year because fishing is often difficult on a windward shore in boisterous weather. Such folk have to depend to a larger extent on estuaries and the foods in mangrove swamps. The people of dolnoro S have hard rock reefs and can build very substantial fish traps denied to some others who have only fragile coral to work with. If these facts are accepted as providing adjustments to the crude figures of area of littoral, the most marked relationship between population and area is between reef and man; the least exact relationship being between uplands and population. It must be stressed that the uplands are only relatively so, because nowhere are they much higher than about 33 feet, except on some sandhills near the northern end of the island. The density of population for the whole of Bentinck Island area in 1940 (the last year when all were present) was 1.7 persons per square mile of total land and reef surface, or over 6.8 persons for each square mile of reef. Since part of the total area is inaccessible, and only used at some risk (as indicated by two tragic episodes accompanying efforts to reach Allen Island in 1940 and 1947) only about 14 square miles of reef were in constant use, *i.e.*, over 8 persons obtained their food on each square mile of reef.

These figures are remarkably high for a "stone age" people. In the southern parts of Australia, even in areas of high rainfall the figures for the most dense populations seemingly went no higher than about one person per two square miles.

This may point up a fact that strand-dwelling populations could have been dominant ones during some parts of the Old Stone Age. If this be so the constantly changing sea levels of Glacial and Interglacial times may have wiped out much of the record of man's early culture history, either by sweeping the relics of his occupation into littoral marine deposits or otherwise destroying them.

POPULATION STATISTICS FOR BENTINCK ISLAND

The population figures between 1948 and 1960 are controlled by the official records and by birth and death registers preserved on Mornington Island. For the period between 1910 and 1948 the data is that remembered by Kaiadilt people and passed to the present writer in the form of genealogical information. Providers of data included some who were already from 10 to 15 years of age in 1910 and hence are probably reasonably reliable witnesses, as far back as about that year. They and most of the other persons belonging to the island furnished their individual genealogical data. When this had been cross-checked and linked together with the similar statements from other sources, so much of the data fell together that a relatively complete record was obtained.

The statistics for the earliest years of the century, 1900-1910, are probably less reliable and are minimal, since they lack data on some infants who died while young and on some old people. Loss of knowledge of older people extended to such details as the names of their totems, less often the birth place name; seldom were birth place name and totem both forgotten for any one person.

Approximations to ages were worked out on all available information. Various marker dates were available. Halleys Comet, the loss of the ship *Douglas Mawson* which sent much flotsam ashore, known major cyclones, the passage of different types of ships trading to Boroloola and other Gulf ports were useful. The landings of Dr. W. Roth, the Protector of Aborigines for North Queensland, in 1901, the beginning of trepang fishing near the island by Mornington Islanders, and the several known attempts of missioners to contact the islanders at intervals of several years have furnished time marker information. The succession of births was established for very many people. The raw information, when examined for internal consistency, proved to give a realistic picture of the interrelations and vital statistics of these people. Principal difficulties encountered were in establishing generation level of a few of those whose *-ngati* or birthplace names and totemic ones were the same in two successive generations. A typical example of this was the man who is recorded in the *List of people* as W2 whose -ngati name was not obtained because of his partial misidentification with his son W3. The identification was made the more difficult because, at his father's death, W3 took one of his father's wives as his own, so that at first it was thought there was only one man involved.

The killings of people by a white raid about 1918 resulted in the stated deaths of eleven people. It is interesting to note how quickly this gap in the ranks was filled by new births. Statistically the injury caused merely a ripple in the population curve.

In the last decade, under the Presbyterian Mission regime 10 infant deaths have occurred, when the population level lay between

72 and 80 persons. In the previous decade 8 children in all were remembered as having died, several of them about the time of stress between 1944 and 1949. Allowing for the greater population and the greater stress the loss was proportionately the same and could be carried in rough statistics as an annual loss of one child. For the 1920-1929 and 1930-1939 periods only 4 children in each of the periods

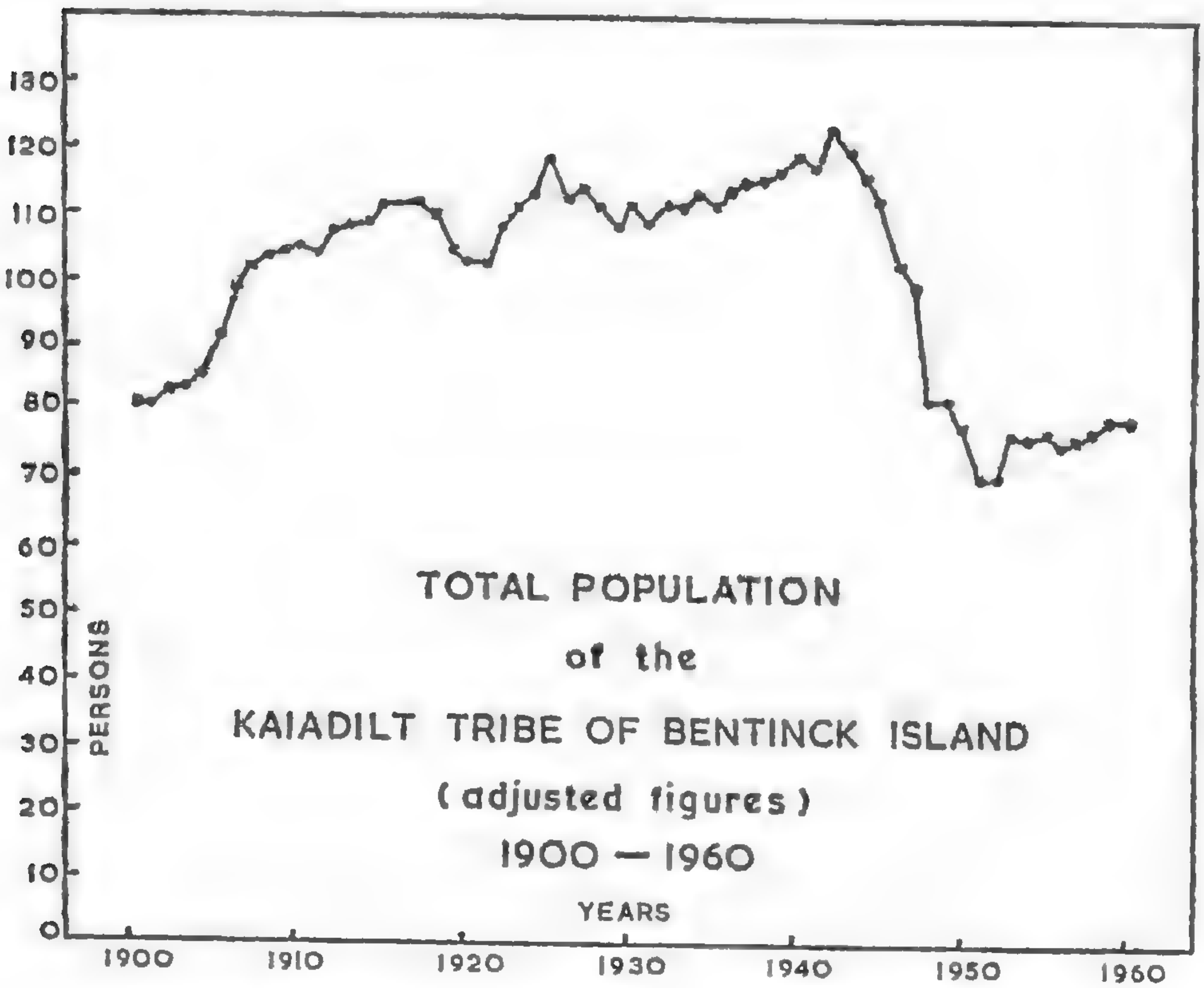

Fig. 1. Adjusted figures for the total population of the Kaiadilt tribe of Bentinck Island, 1900-1960. The data includes the people removed from Allen Island and held at Aurukun between 1941 and 1953.

are remembered as having died in infancy. This may suggest that the statistics are warped by lack of records of up to 6 children per decade. In the 1920-1940 period this suspected loss possibly was of minor significance and may be carried as a deficiency in record of one child per year for the period 1920-1929 and none for the other decade. For the two periods 1900-1909, 1910-1919 at least one additional person per annum should perhaps be added to make an adjusted population figure. It is more difficult to check the data prior to 1920 for adults who may have lived but who are not remembered by name. Inspection of the genealogies enable rough estimates of corrections for this deficiency to be suggested. The addition of an arbitrary figure of 5 persons for the 1900-1909 and 2 for the period 1910-1919 has been allowed to prevent any undue warping of the data through existence of adult persons who were present but whose data has not been recovered. The parentage of persons born prior to the 1900 period is frequently listed as unknown. The mother has been carried in statistics until at least two years after the birth of the last child and the male parent until the year of the child's birth, as a minimum.

With the corrections listed above, the statistics on the Bentinck Islanders, as shown in the attached graph (fig. 1), can be accepted as fully covering the population from 1900-1920 and without any correcting figures should be valid for the period from 1920-1960 within the limits of $\pm$ 1 person in any one year.

The loose data available for age determination may have introduced an error whose magnitude is difficult to estimate. It seems possible that the data can be accepted as reasonably correct since the known dates of birth of children in the 1950-60 decade has enabled the calculation of a birth rate which suggests that earlier statistics are concordant even though developed from the less reliable sources. For the purpose of the present relatively crude analysis they are accepted as correct.

It must be noted that the breakdown by dolnoro of birth, in the second diagram (fig. 2), does not indicate directly the size of each breeding dolnoro group. A married woman usually lives with the dolnorodangka listed as father of her children; the assembly of the data to show the actual breakdown, at any given time, of the dolnoro into breeding units, is a separate task which may require the acquisition of further data on such facts as the mean period of widow-hood between marriages (probably not great, although in a few known instances extended for years after the death of the husband) and the periods over which women visit the dolnoro of their male parent after marriage (said at times to be considerable). The differences between the two methods of listing dolnoro populations may not lead to very great differences in statistical detail because inter-dolnoro marriages are probably all on a one for one exchange basis, except where the women have been taken and held as the result of killings. Because of the existence of a system of vendetta, such stealings are likely to balance out since a male of one dolnoro is likely to be killed in revenge for the death of a man of the other. In the larger dolnoro a proportion of the women are kept in marriage within the dolnoro of their male parent. This type of endogamous marriage has sanction, as being the best one, by men of dolnoro S, T and U and X, although men of the other dolnoro, whose numbers are fewer, consider other marriage ways are better. In 122 listed marriages 26 or 21 per cent were endogamous, *i.e.*, were within the dolnoro. The percentages for different dolnoro ranged from 0 per cent to 36 per cent as follows:

S 36 per cent, T 18 per cent, U 17 per cent, X 14 per cent, but V, W, Y and Z men's marriages were all with women of other dolnoro.

DATA REGARDING CAUSES OF DEATH

From the statements of aborigines and Mission registers an attempt has been made to classify the causes of death for the period 1910-1960 and to record them as percentages of all deaths:—

	Per cent.	
Natural causes	53	
Killings by Kaiadilt persons	18	
Drownings	13	
Cause of death unknown	8	
Killings by Europeans	7	(3 occasions)
	99	

There was one case of suspected suicide of a woman after the drowning of her child, one case of snake bite and another of jelly-fish stinging. Among the stated "natural" causes of death was one "dying of cold and rain in the South-East Trade wind season (winter)"; the drownings included those lost at night by the rising of the tide during fogs, when direction is obscured. The last named is a special hazard determined by the fact that low tides fall always at night in this part of the Gulf of Carpentaria, necessitating much gathering of food by night. A complementary type of death hazard was that indicated by the relatively numerous instances of killings of men, assailed by night as they came ashore, carrying the food they had taken.

DEATHS

Period.	No. of deaths over 5-year period.	Mean population.	Approximate annual rate per 1,000.
1910-1914	6	105	11
1915-1919	17	107	31
1920-1924	6	110	10
1925-1929	23	112	41
1930-1934	11	111	20
1935-1939	12	115	21
1940-1944	22	120	35
1945-1949	51	100	100
1950-1954	24	74	65
1955-1959	3	88	7

In the period of greatest stress, 1947-48, the death rate was near to 260 per 1,000. The high rate in the 1915-1919 period can be attributed to a raid by white men about the year 1918, when 11 persons were killed.

The rather higher death rate in the 1925-1929 period is put down to natural causes since the period was relatively free of interhordal conflicts (20 deaths by natural causes to only one killing). The similar interval 1940-1944, was the reverse, there being 12 killings to 9 deaths by natural causes. At the beginning of this period the population was building up to its highest point (123 in 1942). In the 1945-1949 period there were 23 deaths by natural causes and 11 by killings. Another important death factor was that of drowning.

In 1947 factional fights intensified and Dongkororeingati Kulkitj, abandoning most of his wives, but taking four and many of his children, fled from Bentinck Island with the intention of reaching Allen Island. The rafts were caught in a storm and Dongkororeingati lost his life together with thirteen others. The greatest previous recorded number in a single year was in 1940 when the same attempted journey to Allen Island was made by Minakuringati and 14 companions while escaping from a fight. This resulted in the drowning of three persons.

The first of these drownings constitutes the greatest single disaster recalled by living Kaiadilt people, paralleled only by the raid by an unidentified white man with helpers who rode a horse across Bentinck Island, accompanied by dogs, shooting down all he could see.

This happened about the year 1918; 11 persons are stated to have been either killed or died later from the effects of the attack.

Allen Island is seen to be an escape valve for over-population; but the escape door leads escapees towards probable elimination. First hazard for an escaping group was the chance of drowning. The two recorded major movements of people to Allen Island from Bentinck in 1940 and 1947 had survival ratios as follows:—

	No. departing.	No. drowned.	Percentage survival.
1940	15	3	80
1947	19	14	26

The Allen Island group of 1940 probably went there a little prior to the 11th May, 1940, since Aurukun records indicate a child, subsequently given the white name of Ann, was born on or about that date. Other records show she was born at the northernmost point of Allen Island.

The 1940 party did have children who were born there in 1940-1941, but it is a fact that no person listed as a Kaiadilt who was remembered as having been born between 1900 and 1940 had Allen Island given as place of birth. This may indicate the relative rarity of return to Bentinck Island from that island. A statement from an old Lardiil woman suggests that people who went to Allen Island were subject to attack from roving mainland natives. When there were people on Allen Island the fact was known to all because of their campfire smokes.

The geographical classification used by Kaiadilt recognizes two categories of island. The smaller islands were called Dangkawaridulk, "men absent lands" while Bentinck Island was "land of all", or Dulkawalnged. This governed the allotment of dolnoro territories—the offshore islands were regarded only as appendages to, and not integral parts of dolnoro.

Return to Bentinck Island evidently was possible as is suggested by the probability that people of dolnoro X are descendants of one of the six persons seen by Flinders in 1802. One of the women of this dolnoro possesses a story which seems to match the one Flinders gives of his encounter in 1802; survival of the story itself implies that return trips to Bentinck Island were made, as is indeed maintained as true by all Kaiadilt persons.

GROWTH AND DECLINE OF THE BENTINCK ISLAND POPULATION

Between 1915 and 1935 the population of Bentinck Island, with 111 persons, seemed almost to be at its asymptotic maximum value. Its loss of people by a white raid was made good after an eight-year period of oscillation of the population graph. It rose slowly, however, to 123 by 1942; this was its maximum near the onset of a period of continuous decline.

If the adjusted figure of 105 for the population in 1910 is taken as a starting point, it would seem that there was a relatively slow and steady rise of one person in each second year or about 5 per cent per decade from 1910 to 1940.

Under the Mission regime, which began in 1948, there was a decline but after the effects of the more than five years of strain had been overcome by 1952 the population began again to increase, and at a rate higher than when the people were on Bentinck Island, approaching 10 per cent per decade in the new environment. Introduction of other blood, now just beginning, because they are in contact with others, may interfere with the further progress of what has been an interesting little biological experiment from which much can be learned by study of its earlier history.

When the population is broken down into its constituent dolnoro or horde-like groups, figures for both the growth and decline of population are seen to be unevenly distributed between the dolnoro.

Each dolnoro seems to have had its own period of onset of expansion in the earlier part of this century and to have been differently affected by the period of stress. The after-results of the period of stress differ also for each dolnoro. For example, increase in numbers since this time has been largely concentrated in the S dolnoro. Populations of all the other dolnoro have remained practically static, while S dolnoro population has increased from 21 to 29 persons (*i.e.*, by nearly 40 per cent). The leading man of this dolnoro is a dominant individual who has 5 wives and 7 children. It is of some interest that his dolnoro has had the largest percentage of marriages within the horde (36 per cent) and it has been numerically the strongest dolnoro in each year for which records are available. Two of this man's wives are from his own dolnoro and these have borne four of his children.

A closer look at the history of this and other dolnoro may be of interest, for while the Kaiadilt were an expanding group in the earlier

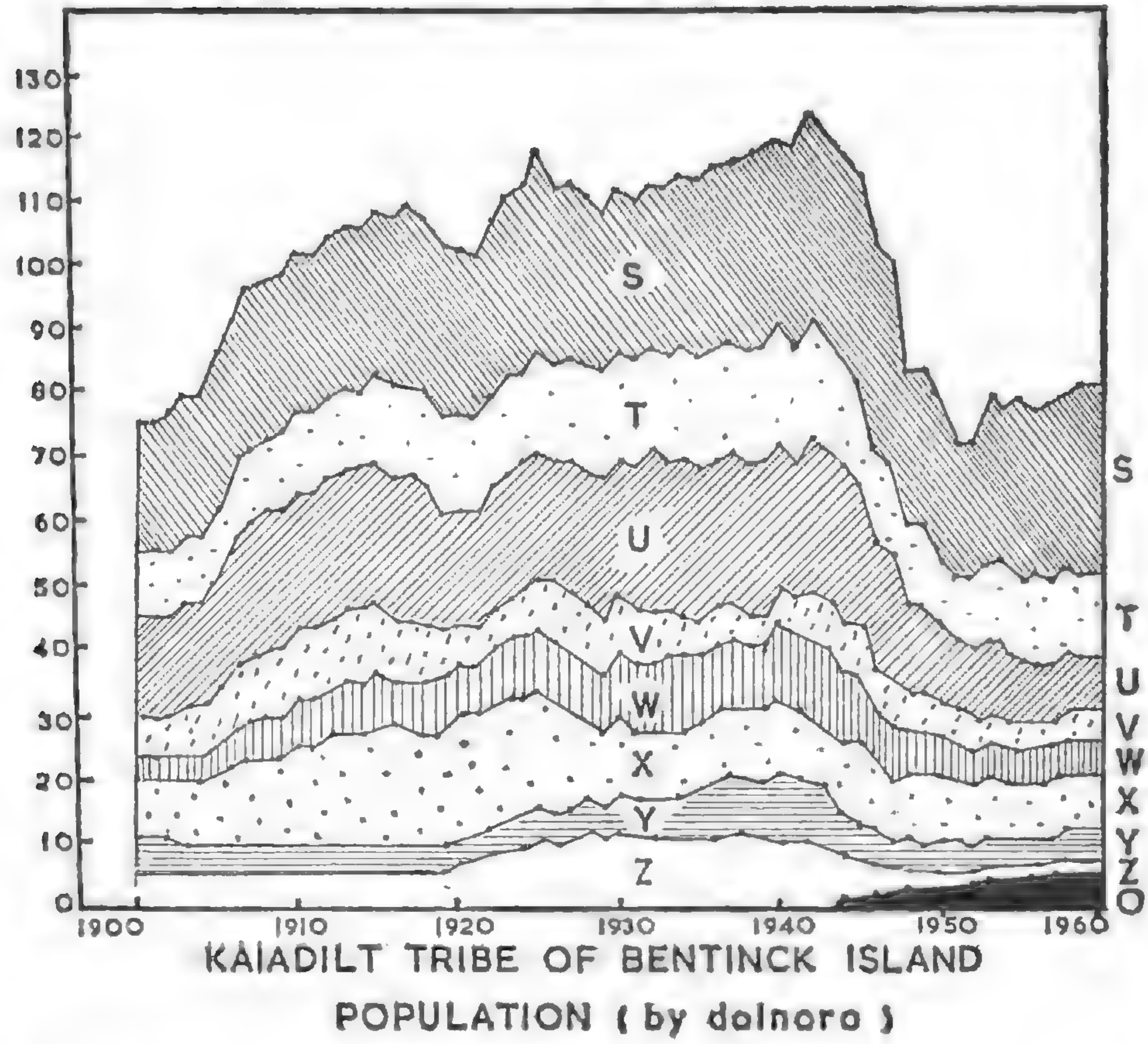

Fig. 2. Population of the Kaiadilt tribe of Bentinck Island, showing numbers composing the eight *dolnoro*. The top line shows the uncorrected figure for the whole population, 1900-1960.

years of the century the rates of growth of individual dolnoro were very different.

In the dolnoro S which already seems to have had the largest population in 1900, the growth was rather slow, increasing from 20 to 25 in the first decade and rising to 27 in 1918; two men were killed by whites about that year and there were 24 present in 1920; a decade later they numbered 25, rising to 29 in 1940 and to 32, their peak population, in the same year as the top population of 123 for the Kaiadilt as a whole. Until the last year of the subsequent period of stress this population of 32 remained, with a 25 per cent drop to 24 in the last few months, principally from drownings.

On arrival on Mornington Island they showed relatively few after-effects of the period of stress and their numbers increased steadily until in 1960 they were only two short of their highest known earlier population.

The dolnoro T population originally was small. It expanded slowly and steadily throughout the period under consideration from 1900 until 1942. Their territory is on the unsheltered eastern side and several drownings on reefs exposed to rough seas in the south-east trade winds season helped to keep their numbers in check. Several also died by drowning during the period of stress after 1940. Those rescued in 1947 and 1948 were weak and some of them died after reaching Mornington Island. Infants who were stillborn and ones who died shortly after birth were relatively numerous in this dolnoro. It has not increased its numbers.

The population of dolnoro U commenced to expand about 1906. It suffered loss of three persons during the raid by white men about 1918. This gave a slight check to population numbers but there was recovery by 1926. With minor oscillations this population increased, showing no marked signs of stress, despite five killings about 1942; they only commenced a decline from 25 to 20 in 1944. Drownings and the side effects of their experiences before August 1947 drastically reduced their number to 14 in 1948. Some died after they were rescued from their island. Women capable of child bearing were few; young males predominated among those who survived. Only one child (a girl of Kaiadilt descent only on her father's side) has been born to a member of the dolnoro since then. Young men of the dolnoro who are now in their twenties, have not yet begun to produce children, although some of them are married.

Dolnoro V whose territory was on the south coast, with a shore line much exposed to the south-eastern trade winds was a small group of four, at the beginning of the century. Its period of expansion was between 1906 and 1918 to 11 persons. It suffered several losses during the raid by white men in that year, and, except for a temporary expansion in mid-twenties, its numbers have dropped rather steadily and slowly since then. During the period of stress in the 1940's total numbers fell by one only, although three persons were killed in quarrels. In 1960 there were only four surviving persons, the same number as were remembered as being alive near the turn of the century.

In 1900 dolnoro W population was smaller than for V, with only four known persons, but increased steadily to a maximum of 12 in

1942. Those who escaped drowning when voyaging to Allen Island in 1940, temporarily disappeared from the Kaiadilt population after being apprehended for the murder on that island in 1941. Taken to Aurukun Mission they were not again united with their kinsfolk on Mornington Island until September, 1953. Of those who remained on Bentinck Island, in 1940, three men were drowned during raft accidents in the 1940's.

Dolnoro X was the third largest with 19 persons at its period of greatest expansion in 1920, but although it has held third place in rank most of the time until now, it was smaller, with only 9 persons in 1900. This number is the same as it possesses in 1960. Females predominate in the dolnoro. In 1925-1927 there was a spate of deaths, mostly of middle-aged to old women. Only one adult male of the dolnoro remained in 1940. When attacked and deprived of some of his wives, this man with other men and children fled to Allen Island, whence he was taken to Aurukun. One of the women of the dolnoro who remained on Bentinck Island was killed in a quarrel during the period of stress in the 1940's and one old lady died.

A predominance of young and young adult females, some without children, enabled the people of X dolnoro who remained on Bentinck to pass through the difficult years with relatively undepleted numbers.

Dolnoro Y. In 1900 there were 5 persons in this dolnoro, in 1960 there were only 4. In only one decade (1935 to 1944) was it much larger, with a maximum population of 10 in 1940. The period of stress reduced the group to 5 by 1948 there being three killings and one accidental drowning. Two who were weak when they were rescued in 1948, died shortly after being rescued, leaving only 3 in 1952.

Dolnoro Z was small with only 5 persons in 1900, of whom four were males. Population began to increase in 1920 and was maintained between 10 and 11 from 1927 until 1943. By 1940 the sex ratio was equal; then there were deaths by killing of two young girls in quarrels over wives. Deaths of two young men followed and a male killing, prior to June, 1947. This caused extinction of the male line. Two women in their thirties survived the period of stress and are now in their forties. Their later born children are reckoned, of course, in other dolnoro.

Commencing with one part-Kaiadilt child born at Aurukun in 1943 and later ones born on Mornington Island, a small group of mixed Kaiadilt/other tribe hybrids, is building up; there were, in 1960, five such persons. Properly to be counted as part of the Kaiadilt population there are also five persons of three tribes, from elsewhere, who have had clandestine associations with or have married into, and produced children for the Kaiadilt community since they have made contact with the outside world.

FACTORS INVOLVED IN POPULATION CHANGES

Decline:

Study of the Bentinck Island population suggests that four primary factors may have led to the period of stress and catastrophic decline in the population after 1940:—

(*a*) Growth of population to beyond the limit of capacity of the area in which they lived.

(*b*) Conflict between the hordes.

(*c*) Climatic change, in the direction of a deterioration.

(*d*) Catastrophes (*e.g.*, tidal wave, mass drownings).

The climatic vagary may have been instrumental in triggering off the interhordal conflicts which marked the first stage in the catastrophic decline of the 1940's.

It would appear that in a period of stress following one of expansion population diminishes by losses caused in a variety of ways. These can be listed roughly in the order of their importance and impact on the Bentinck Islanders:—

1. Deaths of infants born during the difficult time.
2. Relative lack of births during the period of stress.
3. Inter-hordal killings of adult males and females.
4. Deaths by weakening, especially of older females, and particularly after giving birth.
5. Drownings through "forced" movements as well as through attempts at exploitation of the more dangerous parts of their littoral (perhaps aggravated by weakness due to starvation, combined with a possible lowering of judgment on the part of those participating, under stress of necessity, causing the taking of undue risks).

These deaths added to those which would have occurred under normal conditions had a marked effect on population numbers.

Recovery:

Young adult males and young females tended to survive in greater numbers than others. After recovery from the stress (in this case with a changed environment due to Mission contact and medical attention) births of children were numerous and, after some losses due to a high infantile mortality, some possibly owing to exposure to new diseases in the changed environment, population numbers advanced steadily within the next 10 years. A factor delaying the rise in population after the period of stress was the early deaths of numbers of children who were born to mothers who had been weakened by their experiences in 1947 and 1948. The medical records of the Mission are not very complete but they indicate that many persons were treated for "anaemia" during the period 1949-1952.

INTRODUCTION TO LIST OF THE INHABITANTS OF BENTINCK ISLAND, GIVEN AS APPENDIX A

This list contains, in compressed form, the whole of the genealogical data available in June, 1960, for the Kaiadilt people. From it can be reconstructed the genealogies and basic population data used for the observations made in this report.

Males and females are listed separately, according to their patrilocal and patrilineal horde-like units, called dolnoro. These dolnoro arbitrarily have been assigned letter symbols from S to Z, because they do not have fixed names of their own.

The -ngati or birth-place name of each person is first listed, when available, in capitals and lower case for males, in full capitals for females. Then follows a totemic name, usually that of some food, occasionally that of a natural force or a feature of the landscape. The totemic name is itself followed by the European name, where one has been given to the person after white contact. The numbers with an *f* following the symbol representing the dolnoro, are females, those without are males. So far as possible the persons of each dolnoro are arranged according to succession of birth and the children also are so listed within the parental entries; a few casual anomalies of arrangement occur, usually because of the late arrival of correcting data. A few persons who cannot be assigned to dolnoro are listed under the symbol O following the main list, and there is an appendix detailing five persons not of the Kaiadilt tribe who have had marital associations with Bentinck Islanders since they emerged from their long period of isolation on the Southern Wellesley Islands.

Since the -ngati name of the individual incorporates the name of the place of birth it is not generally repeated except when there are anomalies or there is a seeming conflict between place of birth and assignation of dolnoro. Informants usually were careful to draw attention to such discrepancies. Offered explanations were ones such as "his mother had him when she was away from his country" or "she was born in her new father's country", where the new born child had a stepfather.

Married women live with the members of the husband's dolnoro, and her children are dolnorodangka (dolnoro folk) of her husband's horde.

On the death of a husband the wife passes either to her husband's eldest son, or to her husband's brother, whichever is the older, or may be passed on into another dolnoro. Her children by the new husband fall into his dolnoro. Children born just after the death of a prior husband usually are considered to fall in the dolnoro of the deceased man. In a few cases, usually of recent date the dolnoro assignation remained in doubt until resolved after discussion. The probability is that the "value" of the dolnoro as a territorial unit has declined in the twelve years since the people have abandoned their home.

All births and deaths after 1947 were recorded in the Mornington Island Mission Register. Some late entries, based on estimated dates of year of birth were made. Usually these can be recognized as estimates by the arbitrary giving of 1 July as the birth date. Earliest Mission assigned dates of this type may go back to 1941, and in some instances may be no more reliable than ages estimated in this study by other means. All the Mission data appears to have been re-written into the present Register in 1953, some records being from lists on loose sheets of paper. Copies have been made of all available registers and lists, up to June 1960, and are on file in the South Australian Museum collection.

Blood genetics data is given after the other personal and family information. In case of later enquiry it may be noted that the temporary field numbers assigned to blood tests are not recorded herein. They were not the same as the listed anthropometric numbers. The blood data for each person is set out in the following sequence:— ABO, MNSs, Rh, P, Le^a, Fy^a, K, Webb, Jk^a. "Webb" is a rare blood group being described by R. T. Simmons and J. A. Albrey in the Medical Journal of Australia 1962 (*in press*). The tests were done in the Commonwealth Serum Laboratories, Melbourne, by R. T. Simmons, and the results are being discussed in a paper by Simmons, R. T., Tindale, N. B., and Birdsell, J. B. (*in press* 1962).

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DESCRIPTION OF PLATES 10-11

PLATE 10.

Fig. 1. A deserted Bentinck Island cold season camp showing shell water vessels and break-wind, with pile of native yams in foreground. Photograph taken about 1927, before direct white contact. (Photo. attributed to the late R. H. Wilson.)

Fig. 2. Kaiadilt people moving from a temporary camp during their first voluntary encounter with a European, at Baltac, in late 1927. (Photo. attributed to the late R. H. Wilson.)

PLATE 11.

Fig. 1. Group of timorous Bentinck Islanders as seen by W. Roth in June, 1901. The central figure was identified by present day islanders as holding a tjilanganda or mariwu (crude biface stone implement) in his hand. (Photo. by J. F. Bailey.)

Fig. 2. Several Kaiadilt men and a woman dancing before Lardiil men 25 June, 1945, on the occasion of their first brief visit to Mornington Island; the woman in the background is now the oldest living Kaiadilt person, KENAKENABAJANGATI (Sf. 8 of the accompanying list). (Photo. by R. E. Davies.)

APPENDIX A

LIST OF THE KNOWN INHABITANTS OF BENTINCK ISLAND, QUEENSLAND, TO JUNE 1960

Males of Dolnoro S

S.1. Dongkororeingati (birth place name) kulkitji (shark) (totem); born *circa* 1865 at Dongkororei, died *c.* 1918 at Lokoti (places on Bentinck Island *see map*); mode of death, shot by white man; aged 53 years; father——; mother——; married Wf.1; 3 children, S.3, Sf.4, S.5.

S.2. Tondoingati bidjarupa (dugong); b. *c.* 1865, d. *c.* 1930; speared while in the sea at Kungari by one of the brothers of Zf.4, aged *c.* 65 years; f.——; m.——; 3 wives Sf.3, Xf.1, Xf.3; 9 children, Sf.11, Sf.12 (by Sf.3), Sf. 8, S.10, Sf.10 (by Xf.1), S.8, S.15, S.17, Sf.17 (by Xf.3).

S.3. Kongarangati kanatu (oil fish); b. *c.* 1895, d. *c.* 1915; killed at Kongara in a fight, by prospective wife's brother; aged *c.* 20 years; was to have married Sf.8; f. S.1; m. Wf.1. The personalities of S.3 and T.2 seem to have become confused in some informants' minds and the record as given may be inaccurate. They evidently were step-brothers who were born some years apart.

S.4. Berumoingati kanatu (oil fish) and/or airuput (small mackerel); b. *c.* 1885, d. *c.* 1939; speared at Wanaratji, died at Dangkankuru, aged *c.* 44 years, death ascribed to Y.2; f.——; m.——; married Sf.1 (widow of U.22(1)), Sf.2 (probably widow of U.22), Uf.9; 1 child Sf.13 (by Sf.2), no children by either Sf.22 or Uf.9.

Note: This man's number is out of logical sequence because of a late revision.

S.5. Dongkororeingati kulkitji (shark) (also named Odeitepetepe), white name Terry, this name first given during a brief visit to Mornington Island Mission in 1945; the first external contact with whites; b. *c.* 1895, d. 1947; drowned on raft voyage from Bentinck to Allen Island with many others, aged *c.* 53 years; f. S.1; m. Wf.1; married 13 wives; he took only four of them when he and a party fled to Allen Island after a fight in 1947; three of these wives and 7 of his children were among those drowned with him. His wives were, Sf.8, Sf.9 (widow of T.4), Sf.10 (widow of T.3 and S.6), Sf.13, Sf.14, Sf.21, Tf.2 (a widow), Tf.6 (widow of ? T.3), Uf.3 (widow of U.1 and U.6), Uf. 4, Uf.14, Uf.18, Xf.5, in addition he had relations with the unmarried girl Uf.16. 16 children, S.14, S.16, Sf.20 (by Sf.8), S.20 (by Sf.9), Sf.16, Sf.18, S.26 (by Sf.13), Sf.22 and Yf.3 (by Sf.14, but Y dolnoro attribution of second child not explained), Sf.15, S.18, Sf.23 (by Uf.4 who was said to have been the first or eldest wife), Sf.19 (by Xf.5), S.22, S.25, S.42 (mother's name not recorded). Also he inherited 10 step-children and his widows had 4 by subsequent husbands; Sf.30 (mother Uf.16, unmarried) is attributed to him; this child was adopted and reared by Vf.10 and S.17.

S.6. Berumoingati ngorongkolt ( ); b. *c.* 1895, d. *c.* 1941 at Wanaratji of spear wound inflicted by W.4 who escaped to Allen Island (where in 1941 he shared the killing of a Mornington Islander), aged *c.* 47 years; f.——; m.——; married Sf.10 (widow of T.3), 4 step-children, T.10, T.11, T.14, Tf.13, his widow married S.5.

S.7. Wartadangati kulkitji (shark) also kalbara (white crane) and tjilangind (small rock oyster); b. *c.* 1895, d. *c.* 1944 at Rokoti of a throat infection, with blood, condition known as dorongk, aged *c.* 49 years; f.——; m.——; married Sf.7, Uf.6, Uf.7, Vf.7. Six children, V.5, Vf.8 (by Sf.7), V.6, Uf.17 (by Uf.6), Vf.10, V.7 (by Vf.7). Note: The dolnoro associations are not understood and need checking in the field; it seems possible that he changed from V dolnoro to S but his children remained in V; other instances of such a change were cited.)

S.8. Markarukingati tuato (rainbow), white name King Alfred, also called Dingkararangati; b. *c.* 1897, d. 1947 (before June), killed at Lokotai by S.16, aged *c.* 50 years; was killer of Z.8; f. S.2; m. Xf.3; married 6 wives, Sf.16, Sf.18, Uf.7, Uf.15, Uf.17, Zf.2; 4 children, S.21 (by Sf.16), Sf.27, Sf.29 (by Sf.18), Sf.28 (by Zf.2). Note: Uf.20 was his stepchild (by Zf.2) whose real parent has not been recorded; three of his widows passed to his younger brother S.17.

S.9. Tondoingati bidjarupa (dugong), b. c. 1895, d. c. 1945, killed at Maran by Z.7 and Z.8, when he returned from fishing at night time, aged c. 50 years; f.———; m.———; married Uf.10; 2 children, Sf.21, Sf.25.

S.10. Tondoingati boltoko (quail) also called Bilinapangati, white name Kelly, b. c. 1900, d. October 1950 of sickness while in transit by airplane from Mornington Island to Cloncurry Hospital, aged c. 50 years; f. S.2; m. Xf.1; married 4 wives, Uf.7 (widow of S.11, S.7, S.8), Uf.17 (widow of S.8), Tf.9 (widow of U.13, U.10); 4 children, S.24 (by Uf.7), S.23, Sf.33 (by Uf.17), S.30 (by Tf.9); he received Uf.3 (widow of U.6) but passed her to V.5.

S.11. Tondoingati bidjarupa (dugong) also orobari (bonefish), b. c. 1920, d. 1945, after June, at Kougara, killed when he returned from fishing, by two men; f.———; m.———; married unrecorded woman and Uf.7; 2 children, Sf.24, Sf.26 (by Uf.7).

S.12 ——— [son of BALTAENGATI]; b. c. 1904, d. c. 1918 at Burumangi, killed by white man, aged c. 14 years; f.———; m. Tf.2.

S.13. Berumoingati airuput (small mackerel); b. c. 1905, d. c. 1925 of stomach sickness, aged c. 20 years, not married; f. S.4; m. Sf.2.

S.14. Tarurukingati (Tadukingati) kulkitji (shark), white name Buddy; b. c. 1916, d. 1947 before August; killed at Markaruki by S.8, just prior to S.8's own death also by killing; aged c. 31 years; newly married; f. S.5; m. Sf.8; married Uf.13, no children.

S.15. Kongarangati dawart (   ), b. c. 1917, d. October 1943, shot by R.A.A.F. personnel during an unprovoked attack with spears at Milt, c. 26 years, unmarried. f. S.2; m. Xf.3.

S.16. Bokanaijarupangati kambo (rock cod) also debedebe (rock cod), white names Alec, Alex, Alec Allen (also called Ngarangati, corrupted as Naranatjil); b. c. 1920, removed from Allen Island to Mornington Island 10 June or 2 July 1947, a survivor of the raft disaster in which his father and others perished, living June 1960, age c. 40 years; f. S.5; m. Sf.8; married Sf.13 (widow of S.5, his father), Sf.24; 4 children, Sf.34, S.35, S.36, S.39 (by Sf.24).

S.17. Korerungati worobari (bone fish), also lokoti (sheoak tree); white name Percy Loogatha; b. c. 1922, arrived Mornington Island 4 August 1947, living June 1960, age c. 38 years; measured as B.I. no. 1. f. S.2; m. Xf.3; married Sf.16, Sf.18, Vf.10, Zf.2, Zf.4; 7 children, Sf.32 (by Sf.16), S.28, Sf.36, S.40 (by Sf.18), S.32, S.37, Sf.38 (by Vf.10); no children by other wives; the child Sf.30 reared by Vf.10 was adopted from Uf.16, its supposed father was S.5. Blood types:—B, Mss, R_2 R_0, P_1—, Le(a—), Fy(a+), K— Webb—.

S.18. Kabaratjingati boltoko (quail); white name Pat; b. c. 1922, arrived Mornington Island 18 October 1948, living June 1960, age c. 38 years; measured as B.I. no. 4; f. S.5; m. UF.4; married (4 wives), Sf.17, Uf.13 (whom he gave to T.13), Wf.4, Of.1; 8 children, Sf.31, S.29, S.31, Sf.35, S.38, Sf.37 (by Sf.17), S.27 (by Uf.13), S.34 (by Wf.4), no children by Of.1. Blood types:—B, Mss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—.

S.19. Tarurukingati morukadi (   ) also tungalngomoro (   ); white name Gilbert; b. c. 1922, arrived Mornington Island 18 October 1948; d. 24 September 1955 by drowning in a canoe accident off Andrew Island, aged c. 33 years; f. S.5; m. Uf.2; married Tf.7 (widow of Z.3, Z.2, U.10, Z.9), Xf.8 (widow of S.10), Xf.17; no children.

S.20. Kongarangati; b. c. 1925, d. c. 1925, aged c. 1 year; f. S.5; m. Sf.9; [see S.41, out of place, should go here].

S.21. Berumoingati bidjarupa (dugong); b. c. 1934, d. c. 1946 of snake bite, aged c. 12 years; f. S.8; m. Sf.16.

S.22. Rarukungati; b. c. 1938, d. 1947; drowned on raft voyage from Bentinck Island to Allen Island, aged c. 9 years; f. S.5; m.———.

S.23. Kongarangati tapuroro (sword shark), also lokoti (sheoak tree); white name Peter Lugata; b. c. 1939, arrived Mornington Island 4 August 1947; living June 1960, age c. 21 years; f. S.10; m. Uf.17.

S.24. Dolkalatjingati boltoko (quail); white name Roger; b. 1941, arrived Mornington Island 4 August 1947; living June 1960, age 19 years; f. S.10; m. Uf.7.

S.25. Rokotangati; b. c. 1941; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged c. 6 years; f. S.5; m.———.

S.26. Bokanaijarupangati (Bokaumngati); b. c. 1942; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged c. 5 years; f. S.5; m. Sf.13.

S.27. ——— white name Horace; b. 1947-8 after arrival of mother at Mornington Island; d. 28 December 1948 at Mornington Island; aged under 1 year; f. S.18; m. Uf.13.

S.28. ——— white name Robert; b. 9 January 1949 on Mornington Island; d. 9 January 1949; aged 1 day; f. S.17; m. Sf.18.

S.29. ——— white name Malcolm; b. 16 January 1950 on Mornington Island; d. 22 January 1950; aged 6 days; f. S.18; m. Sf.17.

S.30. Njinjilkingati (so named for a place given this name on Mornington Island by Kaiadilt; not Bentinck Island), bidjarup (dugong); white name Duncan; b. 15 February 1950 on Mornington Island; living June 1960; aged 10 years 3 months; f. S.10; m. Tf.9.

S.31. ——— banga (turtle); white name Glenn; b. 1951 on Mornington Island; died before 1959; aged about 6-8 years; f. S.18; m. Sf.17.

S.32. ——— tjoanda (white porpoise); white name Geoffrey; b. 7 February 1952 on Mornington Island; living June 1960; aged 8 years 4 months; f. S.17; m. Vf.10.

S.33. ——— kamara (stone fish); white name Malcolm; b. 15 April 1952 on Mornington Island; living June 1960; aged 8 years 1 month; f. unknown; m. Uf.17 (widow of S.10 for 1 year 6 months before birth of S.33).

S.34 ——— barnkaltji (native companion); white name Benjamin; b. 31 July 1953 on Mornington Island; living June 1960; aged 6 years 10 months; f. S.18; m. Wf.4.

S.35. ——— white name Maxwell; b. 7 September 1953 on Mornington Island; d. 1953 of pneumonia; aged under 3 months; f. S.16; m. Sf.24.

S.36. ——— white name Rodney; b. 11 November 1954 on Mornington Island; living June 1960; age 5 years 6 months; f. S.16; m. Sf.24.

S.37. ——— dangurt (mud crab); white name Neil; b. 12 June 1955 on Mornington Island; living June 1960; age 5 years 0 months; f. S.17; m. Vf.10.

S.38. ——— warunt (goana); white name Harry; b. 8 September 1956 on Mornington Island; living June 1960; age 3 years 9 months; f. S.18; m. Sf.17.

S.39. ——— white name Robin; b. 13 July 1957 on Mornington Island; living June 1960; age 2 years 10 months; f. S.16; m. Sf.24.

S.40. ——— bidjarup (dugong); white name Gerald Baldagu; b. 19 August 1958 on Mornington Island; living June 1960; age 1 year 9 months; f. S.17; m. Sf.18.

S.41. Berumoingati kanatu (oil fish); b. c. 1927; d. 1947, drowned on raft voyage from Bentinck Island to Allen Island; aged c. 20 years. The data on this man is not firm. f.———; m.———.

S.42. Tjodjongati; b. c. 1940; d. c. 1947, drowned on raft voyage from Bentinck to Allen Island; aged c. 7 years; f. S.5; m.———.

Females of Dolnoro S

Sf.1. DONGKOREINGATI banga (turtle); b. c. 1875; d. c. 1925 of sickness at Kongarangari; aged c. 50 years; f.———; m.———; married U.22, S.4 an unrecorded T. man; children U7, Uf.5 (by U.22), T.6 (by ?), Sf.13 (by S.4).

Sf.2. TONDOINGATI; b. c. 1875; d. c. 1933 of sickness at Mardanki; aged c. 58 years; f.———; m.———; married U.22, S.4; no children.

Sf.3. RENDJALKAURUNGATI tjudabari (fish hawk); b. c. 1883; d. after 1907 of sickness at Mededingki; aged over 24 years; f.———; m.———; married S.2; previously had had children by V.1; 4 children, V.4, Vf.7 (by V.1), Sf.11, Sf.12 (by S.2).

Sf.4. BANDARANGATI; b. c. 1890; d. c. 1910; aged c. 20 years; not married; f. S.1; m.———.

Sf.5. BEALURUNGATI kulkitji (shark); b. c. 1892; d. c. 1925 of sickness at Baltae; aged c. 33 years; f.———; m.———; married U.4; 1 child, U.12.

Sf.6. BERUMOINGATI; b. c. 1893; d. after 1915; f.———; m.———; married U.4; 1 child, U.13.

Sf.7. WINDJARUKAURUNGATI karwark (queen fish); b. c. 1895; d. c. 1928 of sickness at Wedei; aged c. 33 years; f.———; m.———; married S.7; 2 children, V.5, Vf.8.

Sf.8. KENAKENABAJANGATI bidjarup (dugong); white name VENUS; b. c. 1895, arrived at Mornington Island 2 July 1947 from Allen Island; living June 1960; age c. 65 years; measured as Bl.21; f. S.2; m. Xf.1; married S.5 (had been promised to S.3 but he was killed); 3 children, S.14, S.16, Sf.20. Blood types:—O, Mss, R_1 R_0, P_1—, Le(a−), Fy(a+), K—.

Sf.9. DONGKALATJINGATI (DOLKALATJINGATI) tjariru (stingray); b. c. 1898; d early 1947, speared at night by S.17 at Dangkankuru in mistake for S.8 during general scrimmage; aged c. 49 years; f.———; m.———; married T.4 and later S.5; 3 children, Tf.9, T.13 (by T.4), S.20 (by S.5). The Kaiadilt woman first encountered by Mornington Islander, Gully, on a reef, about 1927.

Sf.10 TONDOINGATI (TONDURINGATI) bidjarupa (dugong); white name ROONGA; b. c. 1907, arrived on Mornington Island 4 August 1947; living June 1960; age c. 53 years; measured as Bl.20; f. S.2; m. Sf.1; married ?T.3, S.6 and U.14; children, T.10, T.11, T.14, Tf.13 (by T.3 or S.6), U.21, Uf.22 (by U.14). Blood types:—O, Mss, R_0, P_1—, Le(a−), Fy(a+), K—, Webb—.

Sf.11. DODJONAPANGATI taliwindi (trumpet shell); b. c. 1907; d. c. 1925 of sickness at Njinjilki; not married; f. S.2; m. Sf.3. Note: Was born in Z dolnoro territory.

Sf.12. DANGGANGURUNGATI mengunguru (queen fish); b. c. 1910; d. c. 1928 of stomach trouble; aged c. 18 years; f. S.2; m. Sf.3; newly married to U.10 at time of death; no children.

Sf.13. WINDJARUKAURUNGATI (RENDJALKAURUNGATI) barantan (bone fish); white name SARAH No. 1; b. c. 1900; arrived on Mornington Island from Allen Island 2 July 1947; living June 1960; age c. 60 years (could be 2 years older); measured as BI. no. 15 (because of her black hair without greyness she was at first considered much younger); f. S.4; m. Sf.1; married S.5 and S.16; 3 children, Sf.16, Sf.18, S.26 (by S.5). Blood types:—B, MNss, R_1 R_0, P_1+, Le(a−), Fy(a+), K—.

Sf.14. KARIKARIWANGATI mandatji (large cat fish); b. c. 1912; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged c. 35 years; f. S.4; m. Sf.2; married S.5 (also probable associations with Y.2); 2 children, Sf. 22 (by S.5), Yf.3 (probably by Y.2).

Sf.15. KONGARANGATI tjaparta (sole); b. c. 1916, d c. 1918, by drowning, after people had been chased out on to reefs by white man, with dogs; aged c. 2 years; f. S.5; m. Uf.4.

Sf.16. RENDJALKAURUNGATI tjoloro (stone fish); white name DONNA, also written as DONA and very incorrectly as NORMA; b. c. 1915, arrived on Mornington Island 4 August 1947; d. 23 December 1950 at Mornington Island; f. S.5; m. Sf. 13; married S.8 and S.17; children, S.21 (by S.8), Sf.32 (by S.17).

Sf.17. MEDEDINGKINGATI tjoanda (white porpoise); white name SALLY; b. c. 1924, arrived on Mornington Island 18 October 1948; living June 1960; age c. 37 years; measured as B.I. no. 30; f. S.2; m. Xf.3; married S.18; 6 children, Sf.31, S.29, S.31, Sf.35, S.38, Sf.37. This is the woman spoken to by McCarthy when investigating the shooting of the native on Sweers Island in 1943. Blood types:—B, Mss, R_1 R_0, P_1—, Le(a−), Fy(a+), K—.

Sf.18. TONDOINGATI kulkitji (shark); white name RHEA, name also written as REA; b. c. 1925, arrived on Mornington Island 4 August 1947; living June 1960; age c. 35 years; measured as BI. no. 31; f. S.5; m. Sf.13; married S.8, S.17; 5 children, Sf.27, Sf.29 (by S.8), S.28, Sf.36, S.40 (by S.17). Blood types:—B, Nss, R_1 R_0, P_1+, Le(a−), Fy(a+), K—.

Sf.19. KONGARANGATI; b. c. 1926; d. c. 1928 at Kombali, in the mangroves of exposure and cold during S.E. trade wind weather and at same time as mother; aged c. 2 years; f. S.5; m. Sf.5.

Sf.20. WANARATJINGATI; b. *c.* 1927; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged *c.* 20 years; f. S.5; m. Sf.8; not married, no children.

Sf.21. KORAWURUNGATI bidjarupa (dugong); white name MATILDA; b. *c.* 1929, arrived on Mornington Island 4 August 1947; d. 5 June 1950, after giving birth to still-born male child on 22 May 1950; aged *c.* 21 years; f. S.9; m. Uf.10; married S.5 but no children; as widow had short marital associations with T.12 and V.3, but neither were considered to be proper marriages; 2 children, Tf.15, T.17 (considered to have been fathered by T.12).

Sf.22. BIRARUKINGATI komi (a fish); b. *c.* 1932; d. *c.* 1937, killed by V.3 whose elder brother should have had her as wife; aged *c.* 5 years; f. S.5; m. Sf.14.

Sf.23. KONGARANGATI, also called KUNTURUNGATI mengunguru (queen fish); white name MARTHA; b. *c.* 1933; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged *c.* 14 years; not married, but had been promised to Z.9; f. S.5; m. Uf.4; not married. Reputed to have been a light skinned person, known as a kandokando.

Sf.24. WERUNGATJINGATI tadaoka (pumpkinhead fish); white name DAWN; b. 1935, arrived on Mornington Island 2 July 1947 from Allen Island; living June 1960; age 25 years; measured as BI. no. 17; f. S.11; m. Uf.7; married S.16; 4 children, Sf.34, S.35, S.36, S.39. Blood types:—O, MNss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka—.

Sf.25. TONDOINGATI bokadji (black hawk); white name MAY; b. *c.* 1936, arrived Mornington Island 4 August 1947; living June 1960; age *c.* 23 years; measured as BI. no. 29; f. S.9; m. Uf.10; married U.17; no children. Blood types:—O, MNss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka+.

Sf.26. KORAREINGATI karwark (queen fish); white name PAULA; b. 1 July 1938 (age given in mission records, not verifiable); arrived Mornington Island 4 August 1947; living June 1960; age 21 years 11 months; f. S.11; m. Uf.7; not married, promised to T.15.

Sf.27. BERUMOINGATI mali (swamp turtle); white name NETTA; b. 1 July 1942 (mission record age, not verifiable); arrived on Mornington Island 4 August 1947; living June 1960; age 17 years 11 months; measured as BI. no. 30; f. S.8; m. Sf.18; not married, not promised. Blood types:—O, Nss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka+.

Sf.28. WARTADANGATI bidjarupa (dugong); white name ETHEL, earlier records give MILDRED (?); b. 30 July or September 1946 (conflicting mission records); arrived Mornington Island 4 August 1947; living June 1960; age 14 years 9 months or 13 years 8 months; measured as BI. no. 40; f. S.8; m. Zf.2; not married, not promised. Blood types:—B, MNss, R_1 R_0, P_1—, Le(a+), Fy(a+), K—.

Sf.29. TONDOINGATI banga (turtle); white name DOLLY; b. March 1946, arrived Mornington Island 4 August 1947; living June 1960; age 14 years 3 months; measured as BI. no. 38; f. S.8; m. Sf.18. Blood types:—B, MNss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—.

Sf.30. WEREKEWEREKENGATI kambo (rock cod); white name MARGARET; b. May 1946 on Sweers Island; arrived Mornington Island 4 August 1947; d. 14 April 1950 on Mornington Island, cause not stated; m. Uf.16 unmarried; child ascribed to S.5; was adopted by S.17 and Vf.10.

Sf.31. ———— white name IRENE; b. July 1948, arrived Mornington Island 18 October 1948; d. 10 January 1949; aged 6 months; f. S.18; m. Sf.17.

Sf.32. ———— white name OLIVE, also known as OLOM; b. 11 October 1948 at Mornington Island; d. 20 February 1950; aged 1 year 4 months. The first child born on Mornington after the evacuation of Bentinck Island; f. S.17; m. Sf.16.

Sf.33. ———— white name NANCY; b. 4 December 1949 at Mornington Island; d. 1950; aged under 1 year; f. S.10; m. Uf.17.

Sf.34. ———— white name DOROTHY; b. 27 May 1950 at Mornington Island; d. 28 August 1951 at Cloncurry Hospital; aged 1 year 3 months; f. S.16; m. Sf.24.

Sf.35. ———— white name MADGE; b. 29 May 1953 at Mornington Island; living June 1960; age 7 years 0 months; f. S.18; m. Sf.17.

Sf.36. ———— white name OLIVE kuluwanda (a small bird); b. 17 July 1953 at Mornington Island; living June 1960; age 6 years 10 months; f. S.17; m. Sf.18.

Sf. 37.———— white name DOROTHY; b. 19 May 1959 at Mornington Island; living June 1960; age 1 year 0 months; f. S.18; m. Sf.17.

Sf.38. ———— white name JOY; b. 3 September 1959 at Mornington Island; living June 1960; age 9 months; f. S.17; m. Vf.10.

Males of Dolnoro T

T.1. Ngolotalkurungaijarupangati kambo (rock cod); b. c. 1880; d. c. 1918; shot by a white man at Minakuri; aged c. 38 years; f.———; m.———; younger sisters were Tf.2 and Tf.3; family if any, not recorded.

T.2. Kongarangati waruku (sun); b. c. 1885; d. c. 1919, killed in a fight; aged c. 34 years; f. or step f. S.1; m. Wf.1; married Wf.2 and Vf.2; 3 children, T.4, Tf.7 (by Wf.2), Tf.8 (by Vf.2).

T.3. Modomodongati bidjarupa (dugong); b. c. 1885; d. c. 1940; drowned at night at Kodakuru; aged c. 55 years; f. T.2; m.———; married Sf.2 and Sf.10; 5 children, T.5 (by Sf.2); T.10, T.11, T.14, Tf.13 (by Sf.10).

T.4. Bitangati, also called Kongarangati, tjilanganda — mariwu (biface palaeolithic stone tool); b. c. 1890; d. probably before 1933, drowned at night while fishing from a raft, ngimi (translated as "outside") Baltac Island; aged c. 43 years; f. T.2; m. Wf.2; married Sf.9; 2 children, Tf.9, T.13.

T.5. Wundurungati (also called Kongarangati) kulkitji (shark); white name Sam; b. c. 1898, arrived Mornington Island 28 October 1948; d. 1 January 1949 at Mornington Island; aged c. 51 years; blind in one eye since childhood; f. T.3; m. Xf.2; married Wf.4; 1 child, Tf.14.

T.6. Kongarangati karwark (queen fish); white name Shorty; b. c. 1905 arrived Mornington Island on 18 October 1948; living June 1960; age c. 55 years; measured as BI. no. 24; f. unrecorded T. man; m. Sf.1; married Wf.3 and Uf.3 (widow of V.5); 1 child, Xf.20 (by Wf.3). Blood types:—B, MNss, R_1 R_0, P_1—, Le(a—), Fy(a+) K—.

T.7. Wojopongati (Waijupungati) koako (curlew); b. c. 1915; d. c. 1944, collapsed and died of sickness while out hunting at Windjarukauru; aged c. 29 years; unmarried; f. (or more likely step-father) S.4; m. Uf.9.

T.8. Wojopongati (Waijupungati) walda (moon); b. c. 1918; d. c. 1934, speared and killed at Dangkokinaijarup; aged c. 14 years; not married; f. (or step-father) Z.3; m. Tf.4.

T.9. Wanggalkoangati ngorongkolt ( ); white name Paul; b. c. 1920, arrived on Mornington Island 4 August 1947; living June 1960; age c. 40 years; measured as BI. no. 8; f. (or more likely step-father) S.4; m. Uf.9; married Tf.12 (widow of U.10); no children. Blood types:—B, MNss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—.

T.10. Wanaratjingati; b. c. 1927; d. c. 1929 at c. 2 years; f. T.3 (or S.6); m. Sf.10.

T.11. Wanaratjingati; b. c. 1930; d. c. 1934 at c. 4 years; f. T.3 (or S.6); m. Sf.10.

T.12. Kongarangati wanikar (pelican (?)); white name Dugal (Dougal) Goongarra (corruption of ngati name); b. c. 1930, arrived on Mornington Island 9 December 1947 after medical inspection trip of Dr. Spalding; living June 1960; age c. 30 years; measured as BI. no. 2; f. (or step-father) S.5; m. Tf.6; married Zf.4; 4 children, Tf.16, Tf.17, T.20, Tf.19; also two stillborn, T.16 and T.18 (unsexed) prior to Tf.16; also suspected father of T.17 and Tf.15 (by Sf.21). Note: Real father of T.12 may have been T.3. Blood types:—O, MNss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka+.

T.13. Pindjarindjingati kalbara (white crane); white name Frederick; b. c. 1933, arrived on Mornington Island 4 August 1947; living June 1960; age c. 27 years; measured as BI. no. 11; f. T.4; m. Sf.9; married Tf.13 and Xf.17; 2 children, Tf.18, T.21 and 1 stillborn unsexed, T.19. Blood types:—O, Mss, R_1 R_1, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka+.

T.14. Mapuru bandeingati; b. c. 1934; d. c. 1935 at c. 1 year; f. T.3 (or S.6); m. Sf.10.

T.15. Kongaraugati karumoko (long tom fish); white name Arthur; b. 1938, arrived on Mornington Island 4 August 1947; living June 1960; age 22 years; f. U.11; m. Uf.12; not married, but promised to Sf.26.

T.16. Stillborn unsexed, b. c. 1949; f. T.12; m. Zf.4.

T.17. Stillborn male, b. 22 May 1950; reputed f. T.12; m. Sf.21 (see note under Sf.21).

T.18. Stillborn (?); not sexed; b. prior to 1951; f. T.12; m. Zf.4.

T.19. Stillborn; not sexed; b. January 1951; f. T.13; m. Uf.13.

T.20. ——— white name Bernard; b. 14 February 1955; living June 1960; age 5 years 3 months; is very blond-haired; f. T.12; m. Zf.4.

T.21. ——— kalbara (white crane); white name Westie Frederick; b. 9 January 1960; living June 1960; age 5 months; f. T.13; m. Xf.17.

Females of Dolnoro T

Tf.1. MAPURABANDELJARUNGATI karwark (queen fish) and/or tantamant ( ); b. c. 1870; d. c. 1933; aged c. 63 years, of mulatji, a poison from the sea; f.———; m.———; married U.1; 3 children, U.6, Uf.4, U.10.

Tf.2. BALTAENGATI tjaparta (sole); b. c. 1883; d. c. 1918; aged c. 35 years. Shot by white man, inland, at Burumangi, child shot from her body in advanced pregnancy; f.———; m.———; brother was T.1; sister was Tf.3; widow of unknown man; married S.5; 1 child, S.12 (by unrecorded earlier husband).

Tf.3. KONGARANGATI debedebe (rock cod); b. c. 1885; d. c. 1925; died of cold wind during storm while fishing in the water of a creek; aged c. 40 years; f.———; m.———; elder brother was T.1 and elder sister Tf.2; married W.2; 1 child, W.5.

Tf.4. MARDANGKINGATI bilti (tern); b. c. 1898; d. c. 1943 at Lokoti (Rokoti); f.———; m.———; married Z.3, Z.2 and Z.5; 5 children, T.8 (by ?), Z.6, Z.7, Zf.3, Zf.4 (by Z.3).

Tf.5. MAPURABANDELJARUNGATI wondo (rain); b. c. 1900; d. c. 1945 of sickness at Kongarai; aged c. 45 years; f.———; m.———; married U.6; 2 children, Uf.13, Uf.14.

Tf.6. KONGARANGATI bidjarupa (dugong); white name POLLY; b. c. 1906, arrived on Mornington Island probably in 1947 group; d. shortly after 1948 but no mission data exists recording her death; f.———; m.———; married T.3 (not sure); S.5; 3 children, Tf.10, Tf.11, T.12 (all probably by T.3).

Tf.7. KORATJINGATI raerupudi (queen fish) and/or wonda = karuwi (rain); white name EDITH; b. c. 1909, arrived on Mornington Island 18 October 1948; living June 1960; age c. 51 years; measured as B.I. no. 33; f. T.2; m. Wf.2; married five times, Z.3, Z.2, U.10, Z.9, S.19; 3 children, Uf.18, U.17, U.18 (all by U.10). Blood types:—B, Nss, R_0, P_1—, Le(a−), Fy(a+), K—.

Tf.8. BELURUNGATI mandatji (cat fish); white name PANSY; b. c. 1917, arrived on Mornington Island 4 August 1947; d. 13 May 1958, missing, believed drowned; after death of son; this considered as a suicide by aborigines; aged c. 41 years; f. T.2; m. Vf.2; married S.6, U.10 and U.14; 1 child, U.19 (by U.10).

Tf.9. MAMBUNGGINGATI debedebe (rock cod); white name ROMA; b. c. 1917, arrived on Mornington Island 4 August 1947; living June 1960; age c. 43 years; measured as BI. no. 16; f. T.4; m. Sf.9; married U.13, U.10 and S.10; 3 children, Uf.21 (by U.13), U.20 (by U.10), and S.30 (by S.10). Blood types:—O, MNss, R_1 R_0, P_1—, Le(a−), Fy(a+), K—, Webb—.

Tf.10. NGILTALNGATI; b. c. 1925; d. 1947; drowned on raft voyage from Bentinck to Allen Island; aged c. 22 years; unmarried; f. (or stepfather) S.5; m. Tf.6. Note: Real father may have been T.3.

Tf.11. TARUKUNGATI; b. c. 1928; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged c. 19 years; unmarried; f. (or stepfather), S.5; m. Tf.6. Note: Real father may have been T.3.

Tf.12. WEREKEWEREKENGATI (TJONGKOMANGATI); b. *c.* 1935 on Sweers Island; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged *c.* 12 years; parentage not recorded.

Tf.13. TURURUNGATI kanatu (oil fish); white name ALISON, (ALLISON); b. *c.* 1936 at Tururu, arrived on Mornington Island 4 August 1947; living June 1960; age *c.* 24 years; measured as BI. no. 23; f. T.3 (or S.6); m. Sf.10; married Y.5; 1 child, Yf.5. Blood types:—B, MNss, R_1 R_0, P_1—, Le(a−), Fy(a+), K—.

Tf.14. KAKONGATI talkuruki (giant kingfisher); white name ISABELLE; b. 1 July 1943, birth estimate in Mornington Island Register, arrived Mornington Island 18 October 1948; living June 1960; age 16 years 11 months; measured as BI. no. 35; not yet married; f. T.5; m. Wf.4. Blood types:—B, Mss, R_1 R_1, P_1—, Le(a−), Fy(a+), K—.

Tf.15. ———— white name MILDRED; b. November 1948 on Mornington Island; d. 23 May 1949; aged 6 months; f. (suspected) T.12; m. (unmarried) Sf.21 (see note under Sf.21).

Tf.16. ———— white name AGNES; b. 18 April 1952 on Mornington Island; living June 1960; aged 8 years 1 month; f. T.12; m. Zf.4.

Tf.17. ———— white name AMY; b. 1953-54; d. 1953-54; f. T.12; m. Zf.4.

Tf.18. ———— kalbara (white crane); white name DAPHNE; b. 4 March 1955 on Mornington Island; living June 1960; aged 4 years 9 months; f. T.13; m. Xf.17.

Tf.19. ———— white name GAY; b. 1 July 1959; d. 14 July 1959; aged 14 days; f. T.12; m. Zf.4.

Males of Dolnoro U

U.1. Banbanngati; b. *c.* 1865 at Banbanbarukeind; d. *c.* 1917; aged *c.* 52 years; f.———; m.———; married Tf.1 and Uf.3 (no issue); 3 children, U.6, Uf.4, U.10 (by Tf.1).

U.2. Njinjilkingati bidjarupa (dugong); b. *c.* 1870; d. *c.* 1918, drowned at Rendjalkauru after being shot at by a white man; aged *c.* 48 years; f.———; m.———; married Uf.1; 2 children, Uf.3, U.9.

U.3. Tjiluangati karwark (queen fish); b. *c.* 1875; d. *c.* 1910, speared and killed in a fight; aged *c.* 35 years; f.———; m.———; married Vf.1; 2 children, Uf.7, Uf.11.

U.4. Modomodongati airuput (small mackarel); b. *c.* 1885; d. after 1915; f.———; m.———; married Sf.5, Sf.6; 2 children, U.12, U.13.

U.5. Markurukandjingati burantant (bone fish); b. *c.* 1895; d. *c.* 1939 at Minakuri of a swelling sickness of the stomach called makoitj which is believed to come after breaking a food eating rule; f.———; m.———; married Vf.4 (widow of W.3), Xf.9 (widow of W.3). Note: 1 stepchild Wf.6 from Vf.4, by W.3).

U.6. (ascribed also to W.) Modomodongati ngorolko, also toato (rainbow) and/or birint (   ); b. *c.* 1895; d. *c.* 1940, drowned at Wunki from a raft (broke a rule by killing a flying fox in the day time and became lost in heavy fog while fishing with bark flares at night), a tall thin man; aged *c.* 45 years; f. U.1; m. Tf.1; married Tf.5, Uf.3 (young widow of his father, U.1); 4 children, Uf.13, Uf.14 (by Tf.5), Uf.15, U.16 (by Uf.3).

U.7. (but could belong to S.) Kabaratjingati karwark (queen fish); b. *c.* 1896; d. *c.* 1920 of stomach sickness at Kongara; not married; aged *c.* 24 years; f. U.22; m. Sf.1.

U.8. Njinjilkingati kadabalt (curlew) and Wardundi (mangrove dwelling rat); b. *c.* 1897; d. *c.* 1928, death attributed to a shot by a white man at Kongarai while alone; aged *c.* 31 years; f.———; m.———; married Uf.10; 1 child, Uf.16.

U.9. Korowaraingati bidjarupa (dugong); b. *c.* 1898; d. *c.* 1918, killed by white man in bush on Bentinck Island; aged *c.* 20 years; unmarried; f. U.2; m. Uf.1.

U.10. Rotjorotjongati tadaoka (pumpkinhead fish); white name Willy; b. *c.* 1900; d. July/August 1945, killed by S.16 at Minakuri; aged *c.* 45 years; his grave seen; his widows still had unhealed mourning slashes on 17 August 1945; f. U.1; m. Tf.1; married six wives, Tf.7, Tf.9, Uf.3 (his father's widow), Tf.8, Xf.9, Sf.12; 4 children, Uf.18, U.17 and U.18 (by Tf.7), U.19 (by Tf.8).

U.11. Kalturingati walda (moon); b. c. 1905; d. c. 1944; a tall man; aged c. 39 years; speared and killed at Mededingki by S.8 who sneaked on him while he was spearing fish; f.———; m.———; married Uf.12; 3 children, U.14, U.15, T.15 (check reason for difference in dolnoro).

U.12. Dodjouapangati tjoanda (white porpoise); b. c. 1912; d. c. 1945; tall young man; unmarried; speared by a man from Minakuri; f. U.4; m. Sf.5.

U.13. Bokanaijarupangati makulda (big headed turtle); b. c. 1915; d. c. 1944; aged c. 29 years; speared at Tjarapand by Z.8, died of wounds at Kongara; f. U.4; m. Sf.5; married Tf.9; 1 child, Uf.21.

U.14. Baltaengati debedobe (rock cod); white name Maurice; b. c. 1932, arrived on Mornington Island 4 August 1947; living June 1960; age c. 28 years; measured as BI. no. 5; f. U.11; m. Uf.12; married Sf.10 and Tf.8; 2 children, U.21, Uf.22 (by Sf.10). Blood types:—B, MNss, R_1 R_1, P_1—, Le(a+), Fy(a+), K—, Webb—.

U.15. Werungati mialt (flat fish); white name Colin; b. c. 1935; arrived on Mornington Island 4 August 1947; d. 20 March 1952; aged c. 17 years; unmarried; but reputed father of Uf.23 (part Kaiadilt) by Lardiil woman IDA.

U.16. Borerungati tjardaruki (crow); white name Desmond; b. 1936; arrived on Mornington Island 4 August 1947; living June 1960; age 24 years; measured as BI. no. 6; not married; f. U.6; m. Uf.3. Blood types:—O, MNss, R_1 R_1, P_1— Le(a−), Fy(a+), K—, Webb—, Jka+.

U.17. Djoragarangati burantant (bone fish); white name Darwin; b. 1 July 1939 (*fide* late entry in Mission Register), arrived on Mornington Island 18 October 1948; living June 1960; age 21 years 0 months; measured as BI. no. 3; f. U.10; m. Tf.7; married Sf.25; no children. Blood types:—B, Nss, R_0, P_1—, Le(a−), Fy(a+), K—.

U.18. Moraringati; white name Donald; b. c. 1941 on Sweers Island; arrived on Mornington Island 18 October 1948; living June 1960; age 19 years; not married; f. U.10; m. Tf.7.

U.19. Tarurukingati murkudi (groper fish); white name Tony; b. 1 July 1942 (*fide* late entry in Mission Register) at Taaro; arrived on Mornington Island 4 August 1947; d. 24 September 1955, drowned in a canoe accident off Forsyth Island; aged 13 years 3 months; f. U.10; m. Tf.8.

U.20. Modomodongati, also called Korowaringati tjadark (   ); white name Roland; b. c. 1945; arrived on Mornington Island 4 August 1947; living June 1960; age c. 15 years; unmarried; measured as BI. no. 37; f. U.10; m. Tf.9. Blood types:—O, Nss, R_1 R_0, P_1—, Le(a−), Fy(a+), K—, Webb—, Jka+.

U.21. ———— male child; b. c. 1947; arrived Mornington Island 4 August 1947; d. c. 1948; aged c. 1 years; f. U.14; m. Sf.10.

U.22. (out of sequence) no name (father of Kabaratji karwark); b.———; d. c. 1904; married Sf.1 (also perhaps Sf.2 but no issue); 2 children, U.7, Uf.5.

Females of Dolnoro U

Uf.1. DANGALBADANGONGATI djingkawarangaloro (south-east wind); b. c. 1875; d. c. 1918; aged c. 43 years; drowned at Pungkalwangki after being shot at by white men f.———; m.———; married U.2; 2 children, Uf.3, U.9.

Uf.2. JUMUTANGATI (YUMATERR of Mission Records); b. c. 1885; d. c. 1940; aged c. 55 years; drowned during a 1940 raft voyage from Bentinck to Allen Island; her son X.5 got there with some of the party; f.———; m.———; married X.2; 1 child, X.5.

Uf.3. BALTAENGATI bidjarupa (dugong); white name EVE; b. c. 1894; arrived on Mornington Island 4 August 1947; d. 1 September 1954; aged c. 64 years; cause of death given as "age"; f. U.2; m. Uf.1; married U.1, U.6, U.10 (she was his father's other wife), S.6, then S.10 who just before his death passed her to V.5 (in October 1950), T.6; 2 children, Uf.15, U.16 (by U.6).

Uf.4. DUBALKARURONGATI tadaoka (pumpkinhead fish); white name MARA; b. c. 1897, arrived on Mornington Island 4 August 1947, was the woman who reported the mass drowning on the voyage by rafts from Bentinck to Allen Island; d. 1948 (after June); aged c. 51 years; f. U.1; m. Tf.1; married S.5; 3 children, Sf.15, S.18, Sf.23.

Uf.5. KABARATJINGATI raeruputa (a white fish), b. c. 1898; d. c. 1908 of sickness at Kongara; aged c. 10 years; f. U.22; m. Sf.1.

Uf.6. TJILIWANGATI karwark (queen fish); b. c. 1905 at Tjiliwa = ? Tjiwiakara; d. c. 1933; aged 28 years, at Markaruki; went out into water, on return her stomach swelled up; f.——; m.——; married S.7; 1 child, Uf.17. (Note that the father's 4 other children by two other wives Sf.7 and Vf.5 are of dolnoro V.)

Uf.7. KALNJIRINGATI balibali (black spotted stingray) and Karwark ( ); white name HANNAH; b. c. 1905; arrived on Mornington Island 4 August 1947; d. August 1947; aged c. 42 years; described as having appearance of an aged woman at death; f. U.3; m. Vf.1; married S.11, S.7, S.10; 3 children, Sf.24, Sf.26 (by S.11), S.24 (by S.10); 2 step-children, Sf.12 and Uf.15 (of earlier marriage in her husband's menage, parentage not recorded).

Uf.8. TARDARUKINGATI (TADABUNBATEREINT) debedehe (rock cod); b. c. 1905; d. c. 1935; aged c. 30 years; f.——; m.——; married V.3; 1 child, Vf.9.

Uf.9. WERUNGATUNGATI boroti (sole); b. c. 1905; d. 1935 at Kongara of fish poisoning from a species of sardine-like fish; aged c. 30 years; f.——; m.——; married S.4; 2 children, T.7, T.9 (probably both children by an earlier husband).

Uf.10. DANGKANKURUNGATI ngarumati (spoonbill); b. c. 1907; d. c. 1944, killed at Taruruki with a spear by Z.8; aged c. 37 years; f.——; m.——; married U.8, S.9; 3 children, Uf.16 (by U.8), Sf.21, Sf.25 (by S.9).

Uf.11. TALMANGKINGATI bidjarupa (dugong); b. c. 1910; d. c. 1945, at Bokatau, of karwar (sickness) after she had been clubbed by her husband (Y.1); aged c. 35 years; f. U.3; m. Vf.1; married Y.1; no children.

Uf.12. DJILAWANGATI (TJIWIAKARANGATI) balibali (black spotted stingray); white name DINNY (sometimes JINNY); b. c. 1912; arrived on Mornington Island 4 August 1947; d. 11 April 1958 of pneumonia; aged c. 46 years; f.——; m.——; married U.11, T.9; 3 children, U.14, U.15, T.15 (parentage of T.15 is ascribed to first husband but T.15 is now claimed as belonging to T.9's dolnoro).

Uf.13. DANGKANKURUNGATI tadaoka (pumpkinhead fish), white name VERA; b. c. 1920; arrived on Mornington Island 18 October 1948; d. 28 March 1951; aged c. 31 years; was pregnant in December 1950, had stillborn child January, blood transfusions at Normanton Hospital 28 January; unable to swallow water 27th March 1951; f. U.6; m. Tf.5; married S.14, S.18 who gave her to T.13 in 1950; 1 child, S.27 (by S.18) and one stillborn child not sexed T.16 (by T.13).

Uf.14. MARALNGATI (DANGKANKURUNGATI) burantant (bone fish); b. c. 1924; d. 1947, drowned on raft voyage from Bentinck to Allen Island; aged c. 23 years; f. U.6; m. Tf.5; married S.5; no children.

Uf.15. OMBOMAKUTARUPANGATI (WOMBAMAKUTARUPAINGATI) tjaparta (sole); b. c. 1927; d. c. 1947 of sickness of the stomach; death attributed to magic, by using her faeces; aged c. 20 years; f. U.6; m. Uf.3; married S.8; no children.

Uf.16. BALTAENGATI bidjarupa (dugong); white name MARGARET BENTINCK; b. c. 1927; arrived on Mornington Island 4 August 1947; d. "shortly after 1950"; aged c. 24 years; f. U.8; m. Uf.10; not married, but taken by S.5 until he was forced to release her; had one child, Sf. 30, attributed to S.5; it was adopted and reared by Vf.10 to whom it has sometimes been ascribed, in error.

Uf.17. RAIARATARUPAINGATI (RAIRAWATARUPAINGATI) tjilangand (biface chopping stone); white name PHOEBE; b. c. 1927; arrived on Mornington Island 4 August 1947; living June 1960; age c. 33 years; measured as BI. no. 28; f. S.7; m. Uf.6; married S.8, S.10; 2 children, S.23, Sf.33 (by S.10); 1 child S.33 after being widow for 1 year 6 months. Blood types:—O, MNss, R_0, P_1—, Le(a—), Fy(a+), K—, Webb—.

Uf.18. KABARATJINGATI; b. c. 1931; d. 1947; drowned on raft voyage from Bentinck to Allen Island; aged c. 16 years; f. U.10; m. Tf.7; newly married to S.5 when she died; no children.

Uf.19. OMBOMAKUTARUPANGATI ngarawunt (blue parrot fish); b. c. 1932; arrived on Mornington Island 4 August 1947; d. 1947, but no record available of her death; aged c. 15 years; father, not recorded; stepmother Uf.3; not married.

Uf.20. RAIARATARUPAINGATI kapinta (water snake) and/or mingingur (woppa fish); white name AMY; b. 1 July 1942 (according to late entry in Mission Register); arrived Mornington Island 4 August 1947; living June 1960; age 17 years 11 months; measured as BI. no. 34; f. stepfather S.8 (real father not recorded); m. Zf.2; not married; no marriage arrangements yet made. Blood types:—O, Mss, R_1 R_2, P_1—, Le(a—), Fy(a+), K—, Webb—.

Uf.21. DANGKANKURUNGATI makulda (big-headed turtle); white name DAPHNE; b. 1942; arrived on Mornington Island 4 August 1947; d. 23 December 1947 of stings of jelly fish, received while swimming; aged 5 years; f. U.13; m. Tf.9.

Uf.22. MILBULKAIKATARANGATI; b. 1945; d. 1945; aged c. 1 week; f. U.14; m. Sf.10.

Uf.23. ——————— white name ALISTAIR; b. 9 July 1952 on Mornington Island; living June 1960; age 7 years 11 months; f. said to be U.15; m. a Lardiil woman, IDA of Mornington Island; a widow not married to U.15 [by some not recognized as belonging to the Bentinck Island people, but regarded as a Lardiil person].

Males of Dolnoro V

V.1. Tarurukingati warungalta (south-east wind); b. c. 1872; d. c. 1918; aged c. 46 years; shot by a white man on horseback at Korombali (identified by his son as in a 1901 photograph taken by J. F. Bailey); f.———; m.———; married Zf.1, also perhaps Sf.3 who passed to S.2; 4 children, V.2, Vf.2, V.3, Vf.6 (by Zf.1), also perhaps V.4, Vf.7 (by Sf.3).

V.2. Tadulkingati (Ngaiangaiangati) jakar (porpoise); b. c. 1893, d. c. 1915; aged c. 22 years; f. V.1; m. Sf.1; not married.

V.3. Tadulkingati mutali (sea-eagle); white name Jack; b. c. 1900; arrived on Mornington Island 4 August 1947; living June 1960; age c. 60 years; measured as BI. no. 7; f. V.1; m. Zf.1; married Uf.8, Xf.9 (no children) and Wf.6; 1 child, Vf.9 (by Uf.8); 2 children, Vf.11, V.8 (by Wf.6) who had Yf.4 by previous husband. Blood types:—O, Mss, R_1 R_2, P_1—, Le(a—), Fy(a—), K—, Webb—, Jka—.

V.4. Tarurukingati jalunta (seaweed); b. c. 1903; d. c. 1918; aged c. 15 years; shot at and killed by white man from a small ship at Baltae (Fowler Island) at same time as his father; f. perhaps V.1 with S.2 as stepfather; m. Sf.3; not married.

V.5. Tarurukingati morukadi (groper fish); white name Pluto; b. c. 1920; arrived on Mornington Island 17 October 1948; living June 1960; age c. 40 years; measured as BI. no. 9; a photograph dated December 1947 with Dr. Spalding is available; f. S.7; m. Sf.7; married Uf.3, widow of U.6 who had first passed to U.10 then to S.10; no children by her; a widower since 1954. Blood types:—O, MNss, R_0, P_1—, Le(a—), Fy(a+), K—, Webb—.

V.6. Wartadangati bulunduntu (   ); b. c. 1925; d. c. 1932, at Minakuri; aged c. 7 years, of kok, or sores all over his body; f. S.7; m. Uf.6.

V.7. Wartadangati bilti (tern); b. c. 1942; d. c. 1946, speared by S.17; aged c. 4 years; f. S.7; m. Vf.7.

V.8. ——————— mingingur (woppa fish); white name James; b. July 1947; arrived on Mornington Island 4 August 1947; d. 12 April 1950; aged 2 years 9 months; f. V.3; m. Wf.6.

Females of Dolnoro V

Vf.1. PINDINGARUPAINGATI balumbant (   ); b. c. 1883; d. c. 1933 of sickness; aged c. 50 years; f.———; m.———; married U.3; 2 children, Uf.7, Uf.11.

Vf.2. JUMUTANGATI jalunta (seaweed); b. c. 1896; d. c. 1927 or after, at Mededingki of sickness; aged c. 31 years; said to have been a short fat woman; f. V.1; m. Zf.1; married T.2, S.5; 2 children, Tf.8 (by T.2), S.19 (by S.5).

Vf.3. TALMANGKINGATI kaiwaruki (big black fish); b. c. 1897; d. c. 1926, at Dongalakara of sickness; face swelled up; aged c. 29 years; f.———; m.———; married W.1; 2 children, Wf.4, Wf.5.

Vf.4. DUNGALAKARANGATI banga (turtle); b. c. 1903; d. c. 1947 at Minakuri of spear wound inflicted by S. 18; aged c. 44 years; f.———; m.———; married Y.2, W.3, U.5; 4 children, Y.3 (by Y.2), W.7, W.8, Wf.6 (by W.3); no children by U.5.

Vf.5. DODJONGAPANGATI kambo (rock cod) and/or bidjarupa (dugong); b. c. 1905; d. c. 1944; speared in an open fight at Marant by S.18 and died at Kongara; aged c. 39 years; f.———; m.———; married S.7; 2 children, Vf.10, V.7.

Vf.6. TJORDJOROBONGATI; b. c. 1906; d. c. 1919, at Tondoi, cause not indicated; aged c. 13 years; f. V.1; m. Zf.1; not married.

Vf.7. DODJONGAPANGATI taliwindi (trumpet shell); b. c. 1905; d. c. 1920, of sickness at Njinjilki; aged c. 15 years; f. V.1; m. Sf.3; not married.

Vf.8. KONGARANGATI bilti (tern); b. c. 1923; d. c. 1937, of stomach trouble at Barkowakar; aged c. 14 years; unmarried; f. S.7; m. Sf.7.

Vf.9. DONGKOROREINGATI warungalta (south-east wind); b. c. 1925; d. c. 1931, at Dongkororei; aged c. 6 years; f. V.3; m. Uf.8.

Vf.10. DONGKOROREINGATI kardakadi (a sea bird); white name MONA; b. c. 1930 (or earlier); arrived on Mornington Island 4 August 1947; living June 1960; aged 30 years (or older); f. S.7; m. Vf.5; married S.17; 3 children, S.32, S.37, Sf.38 (Sf. 30 was an adopted child of Uf.16 (unmarried girl), reputedly by S.5).

Vf 11. KALNJIRINGATI mandatji (cat fish); white name RITA; b. 1 July 1942 (late record in Mission Register); arrived on Mornington Island 4 August 1947; living June 1960; age 17 years 11 months; not married; f. V.3; m. Wf.6.

Males of Dolnoro W

W.1. Kakongati burantant (bone fish); b. c. 1885; d. c. 1915 at Botenki of stomach sickness and diarrhoea; aged c. 30 years; f.———; m.———; married Vf.3; 2 children, Wf.4, Wf.5.

W.2. ————— -ngati toato (rainbow); b. before 1885; d. c. 1925; aged over 40 years; f.———; m.———; married Tf.3, Xf.6, Sf.7; 3 children, W.3 (by Xf.7), W.4 (by Sf.6), W.5 (by Tf.3).

W.3. Markurukandjingati toato (rainbow); b. c. 1905; d. c. 1935; aged c. 30 years, of sickness and hunger because he could not eat; f. W.2; m. Xf.7; married 5 wives, Sf.6 (widow of W.2), Xf.9, Xf.10, Xf.11, Vf.4; 5 children, W.7, W.8, Wf.6 (by Vf.4), Wf.7 (by Xf.9), no children by Xf.6, W.6 (by Xf.11). Xf.10 is said to have "belonged" to W.3 and she had had one child (Xf.14), but she was also stated to have remained "single" all her life; it will be noted that her daughter "belongs" to her mother's dolnoro.

(There are still doubts about the data for this man and his family. He inherited his father's wife Xf.6, who already had a son of the same totem (toato) as himself; his widowed wives were later taken by U.5, a man of the same *ngati* name.)

W.4. Walkareringati toato (rainbow); white name Rainbow; b. before 1910; removed from Allen Island to Aurukun by police in April 1941; d. 5 May 1945, aged over 35 years, of sickness during an influenza epidemic at Aurukun; described as "elderly" at death; f. W.2; m. Xf.6; married Xf.15, Xf.16; 4 children, Wf.8, W.10, Wf.9 (by Xf.15), W.11 (by Xf.16).

W.5. Male child of W.2; b. c. 1922; d. c. 1925; aged c. 3 years, at same time as its mother; f. W.2; m. Tf.3.

W.6. Kakongati kulpanda (*Arca* shell fish); b. c. 1925; d. c. 1945; drowned at Taruruki on south coast of Bentinck Island; aged c. 20 years; not married; f. W.3; m. Xf.11.

W.7. Dangkongarupaingati burantant (bone fish); b. *c.* 1927; d. 1947; drowned during raft voyage from Bentinck to Allen Island; aged *c.* 20 years; unmarried; f. W.3; m. Vf.4.

W.8. Dangkongarupaingati ngarawunt (blue parrot fish); b. *c.* 1930; d. *c.* 1942, aged *c.* 12 years at Dangkongarupai; cause of death not stated; f. W.3; m. Vf.4.

W.9. Walkareringati; b. *c.* 1936; d. 1947; drowned during raft voyage from Bentinck to Allen Island; aged *c.* 11 years; f.———; m.———.

W.10. Minakuringati jakuri (red snapper fish); white name Bobbie Kummari; b. 3 April 1937 (*fide* late entry at Aurukun Mission); removed by police from Allen Island to Aurukun, April 1941; arrived on Mornington Island September 1953; living June 1960; age 23 years; not married; measured as BI. no. 12; f. W.4; m. Xf.15; was born away from his dolnoro. Blood types:—B, Nss, R_1 R_1, P_1—, Le(a—), Fy(a+), K—

W.11. Dalendurungati; white name Barney Walpo; b. 11 April 1940 on Allen Island; removed to Aurukun by police April 1941; arrived on Mornington Island September 1953; living June 1960; age 20 years 2 months; not married; f. W.4; m. Xf.16.

Females of Dolnoro W

Wf.1. KAKONGATI walpukuteri (raft); b. *c.* 1864; d. *c.* 1924; aged *c.* 60 years, "just died"; f.———; m.———; married S.1 (probably was widow of a man of T. dolnoro); 4 children, T.2, Sf.4, S.3, S.5.

Wf.2. DANGKONGARUPAINGATI burantant (bone fish); b. *c.* 1870; d. *c.* 1920; killed in a fight after being chased into the sea at Malunji; aged *c.* 50 years; f.———; m.———; married T.2; 2 children, T.4, Tf.7.

Wf.3. KAKONGATI mali (fresh water turtle); white name LAURA; b. *c.* 1910; arrived on Mornington Island 21 October 1948 on the launch *Martin*; last family to leave Bentinck Island; d. 21 January 1949; aged *c.* 39 years; f.———; m.———; married T.6; 1 child, Xf.20.

Wf.4. DAWARINGATI kulkitji (shark); white name MAUDIE PAT; b. *c.* 1913 at Dawarinap; took part in a short visit to Mornington Island July 1945; arrived permanently Mornington Island 18 October 1948; living June 1960; age *c.* 47 years; measured as BI. no. 32; f. W.1; m. Vf.3; married Y.1, T.5, X.3, S.18; 5 children, Y.5, Y.6 (by Y.1), Tf.14 (by T.5), Xf.20 (by X.3), S.34 (by S.18). Blood types:—B, Mss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—.

Wf.5. BOTENKINGATI burantant (bone fish); b. *c.* 1917; d. *c.* 1937; killed at Biraruki, struck down by Y.1, her husband; aged *c.* 20 years; f. W.1; m. Vf.3; married Y.1; no children.

Wf.6. BIRARUKINGATI dadowokara (brown fish); white name JENNY; b. *c.* 1922; arrived on Mornington Island 4 August 1947; living June 1960; age *c.* 38 years; measured as BI. no. 19; f. W.3 (U.5 is a stepfather); m. Vf.4; married Y.2, V.3; 3 children, Yf.4 (by Y.2), Vf.4 (considered as V. dolnoro but probably belongs to Y.3, V.8 (by V.3). Blood types:—B, Nss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—.

Wf.7. DANGKONGARUPAINGATI jaokati (jabiru); white name DULCIE; b. *c.* 1925; removed from Allen Island to Aurukun by police in April 1941 (age then estimated as 14-15 years); living at Aurukun Mission June 1960; not seen, but reported alive by Rev. W. F. MacKenzie; aged *c.* 35 years; f. W.3; m. Xf.9; married Edward Munukka Koondoombin of Aurukun; 2 children, Of.1, Of.3.

Wf.8. WALKARERINGATI ————; b. *c.* 1933; d. *c.* 1935 at Minakuri; aged *c.* 2 years; f. W.4; m. Xf.15.

Wf.9. DALENDURUNGATI riningati (tiger shark); white name JUDY WALPO; b. 15 August 1940 on Allen Island (*fide* Aurukun Mission Records); removed to Aurukun by police in April 1941; arrived on Mornington Island September 1953; living June 1960; age 19 years 10 months; not married; f. W.4; m. Xf.15.

Males of Dolnoro X

X.1. Minakuringati ————; b. c. 1855; d. probably before 1900; f.———; m.———; married———; 1 known child, Xf.1.

X.2. Minakuringati kulkitji (shark); b. c. 1880; d. c. 1925, of sickness of stomach at Walkareri; f.———; m.———; married 3 wives, Xf.4, Uf.2, Yf.1; 7 children, X.4, Xf.11, Xf.13 (by Xf.4), X.5 (by Uf.2), Xf.8, Xf.10, X.6, Xf.15 (by Yf.1).

X.3. Dalwaingati; b. c. 1885; no record of death but perhaps between 1944 and 1946; f.———; m.———; married Wf. 4 and another; 2 children, Xf.12 (by unrecorded wife), Xf.20 (by Wf.4).

X.4. Birarukingati kulkitji (shark); b. c. 1903; d. c. 1936; killed at Dalwa on Albinia Island; aged c. 33 years; f. X.2; m. Xf.4; married Xf.12 (widow of Y.2); 1 child, Xf.17.

X.5. Minakuringati kulkitji (shark); white name Shark Koolkitcha, given at Aurukun; b. c. 1905; removed from Allen Island to Aurukun by police in April 1941, after killing of a Mornington Island Mission native named Cripple Jack; arrived on Mornington Island from Aurukun September 1953; living June 1960; age c. 55 years; measured as BI, no. 10; f. X.2; m. Uf.2; married Xf.14; 3 children, Xf.18, Xf.19, X.7. Rev. MacKenzie considers this child is by an unknown Aurukun man, principally on the ground that X.5 is reputed to have "castrated" himself in 1941 while in jail at Cloncurry on trial for the murder of Cripple Jack at Allen Island. In the eyes of a Forsyth Islander this family was a model one; the marriage was "straight" and others should have "gone this way". Blood types:—O, Nss, R_1 R_0, P_1—, Le(a+), Fy(a+), K—, Webb—.

X.6. Unggultakaruruki [ngati] ———— (fish); b. c. 1915; d. "as baby"; aged c. 1 year; f. X.2; m. Yf.1. (The ngati name of this child probably has been incorrectly recorded and it may be a totem name.)

X.7. "Kooindoambin" (name in Aurukun records) kulkitji (shark); white name Royce; b. 23 October 1950 at Aurukun; arrived on Mornington Island September 1953; living June 1960; age 9 years 8 months; f. ostensibly X.5 (but see note above); m. Xf.14.

Females of Dolnoro X

Xf.1. BARAKURUNGATI mariwu (oyster pick stone); b. c. 1875; d. after 1910 of poisoning from food she had eaten; aged over 35 years; f. X.1; m. not indicated; married S.2; 3 children, Sf.8, S.10, Sf.10.

Xf.2. MEANGATI leband (brown fish); b. c. 1880 at Mean = Miant; d. c. 1940, of sickness at Bilmaru; f.———; m.———; married T.3; 1 child T.5 (may have been stepchild only of T.3).

Xf.3. MOROKONOBAINGATI karnda (bushfire) and tantamant (water spout); karnda was the "proper one"; b. c. 1880; was shot at by white man c. 1918 but escaped; died 1946 or 1947 at Baltae of sickness; aged c. 67 years; f.———; m.———; married S.2; 4 children, S.8, S.15, S.17, Sf.17.

Xf.4. WARANTJINGATI bidjarupa (dugong); b. c. 1883; d. 1947, at Dangkongarupai of sickness; aged c. 64 years; f.———; m.———; married X.2; 3 children, X.4, Xf.11, Xf.13.

Xf.5. KUDAURUNGATI ————; b. c. 1883; d. c. 1928, in the mangroves at Kombali of exposure and cold in south-east trade wind weather; described as having a large growth on left side of her body which stretched down to her feet; this when it grew big, she supported under her arm; aged c. 45 years; f.———; m.———; married S.5; 1 child, Sf.19.

Xf.6. BADATJINGATI ————; b. c 1885, outside her dolnoro area; d. c. 1920, at Kuldungki of sickness; aged c. 35 years; f.———; m.———; married W.2, then her husband's son, W.3; 1 child, W.4 (by W.2).

Xf.7. WARANTJINGATI tantamant (water spout); b. c. 1888; d. c. 1925 at Markaruki; aged c. 37 years; f.———; m.———; married W.2; 1 child, W.3.

Xf.8. MINAKURINGATI kulkitji (shark); white name SUSIE; b. c. 1905; arrived on Mornington Island 4 August 1947; living June 1960; age *c.* 55 years; measured as BI. no. 22; f. X.2; m. Yf.1; married S.10, S.19; now a widow; no children. Blood types:—O, Nss, R_1 R_1, P_1—, Le(a—), Fy(a+), K—, Webb—.

Xf.9. KAWULNJIRINGATI wardundi (mangrove-dwelling rat); b. *c.* 1910; d. *c.* 1930 at Tondoi (Dundui); aged *c.* 20 years; f.———; m.———; married V.3; no children.

Xf.10. PAKAITJINGATI worobari (bone fish); white name SARAH No. 2; b. *c.* 1907 at Bakuendja = Pakaitji on Dalwai Island; removed from Allen Island to Aurukun by police in April 1941; arrived on Mornington Island September 1953; living June 1960; age *c.* 53 years; measured as BI. no. 18; is a very deaf woman; considered as a widow now; said to have remained "single all her life" although she had had a child and "belonged" to W.3; f. X.2; m. Yf.1; 1 child, Xf.14 (father unknown). Blood types:—O, Nss, R_1 R_1, P_1—, Le(a+), Fy(a+), K—, Webb—, Jka—.

Xf.11. MINAKURINGATI kulkitji (shark); b. *c.* 1907; d. *c.* 1928 of sickness; aged *c.* 21 years; f. X.2; m. Xf.4; married W.3; 1 child, W.6.

Xf.12. MINAKURINGATI bidjarupa (dugong); white name MOLLY BENTINCK given in 1945; b. *c.* 1910; d. *c.* 1946 at Dangkankuru, by spearing; f. X.3; m.———; married Y.2, X.4; 2 children, Y.4 (by Y.2), Xf.17 (by X.4).

Xf.13. MINAKURINGATI kulkitji (shark); b. *c.* 1912; d. *c.* 1927; aged *c.* 15 years; not married; f. X.2; m. Xf.4.

Xf.14. MINAKURINGATI walpu (raft), tjariru (flat-tailed stingray) and/or toato (rainbow); white name JEAN TAWDU; b. *c.* 1918; removed from Allen Island to Aurukun by police April 1941; died 29 April 1953, from sickness and rib injury received in a fight with another woman; aged *c.* 35 years; f. unknown; m. Xf.10; married X.5; 3 children, Xf.18, Xf.19, X.7 (see notes under X.5).

Xf.15. MOROKONDBAINGATI walawa (a fish); white name MOLLY WOLAU, WOOLA or OOLA (as used at Aurukun); b. *c.* 1919 on Dalwai Island; removed from Allen Island to Aurukun by police April 1941; arrived on Mornington Island September 1953; living June 1960; age *c.* 41 years; measured as BI. no. 14; f. X.2; m. Yf.1; married W.4, then Robert Kongnampa of Aurukun on 20 February 1946; also had a child by Nigel Pootdemunka of Kendall River; 5 children, Wf.8, W.10, Wf.9 (by W.4), Of.3 (by Robert), O.1 (by Nigel). Blood types:—O, MNss, R_1 R_1, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka—.

Xf.16. MEANGATI bidjarupa (dugong); white name "OOJINJINT"; b. *c.* 1920; removed from Allen Island 1941 by police and died at Mornington Island in 1941 from weakness after giving birth; her child was taken to the father at Aurukun, 17 September 1941; f.———; m.———; married W.4; 1 child, W.11.

Xf.17. MINAKURINGATI kulkitji (shark); white name CARMEL; b. *c.* 1936; arrived on Mornington Island 18 October 1948; living June 1960; age *c.* 24 years; measured as BI. no. 26; f. X.4; m. Xf.12; married S.19, T.13; 1 child, T.21 (by T.13). Blood types:—O, Nss, R_2 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—.

Xf.18. TALIWINDIWURUNGATI kulkitji (shark); white name ANN OOLOOKO (or) OOLOKA; b. 11 May 1940 (*fide* Aurukun records), on Allen Island; removed to Aurukun April 1941; arrived on Mornington Island September 1953; living June 1960; age 20 years 1 month; not married; f. X.5; m. Xf.14.

Xf.19. ————; white name EMILY; b. 17 August 1943 at Aurukun; d. 7 May 1950 at Aurukun; aged 6 years 9 months; f. X.5; m. Xf.14.

Xf.20. MINAKURINGATI banga (turtle); white name ELSIE; b. 3 July 1945, ostensibly at Minakuri but actually on Mornington Island on day mother was taken back to Bentinck Island (after first short visit); returned permanently to Mornington Island 18 October 1948; living June 1960; age 14 years 11 months; measured as BI. no. 41; f. X.3; m. Wf.4. Note: The father was also said to be S.18, which may suggest X.3 died before her birth. Blood types:—O, Mss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka+.

Xf.21. MINAKURINGATI raerupuda (a fish); white name SYLVIA; b. 3 May 1947; arrived on Mornington Island 21 October 1948 (last child to arrive); living June 1960; age 13 years 1 month; measured as BI. no. 42; f. T.6; m. Wf.3 (reason for child being in dolnoro X. not yet evident). Blood types:—O, Nss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—, Webb—, Jka+.

Males of Dolnoro Y

Y.1. Tawaringati kulkitji (shark); b. *c.* 1900; d. *c.* 1940; killed with spear at Munawurui by S.8; aged *c.* 40 years; "a tall man"; f.———; m.———; married Wf.4, Wf.5, Uf.11; 2 children, Y.5, Y.6 (by Wf.4).

Y.2. Birarukingati bidjarupa (dugong) and/or Walpu (raft); b. *c.* 1905; d. *c.* 1945; drowned from a raft in an accident; aged *c.* 40 years (widow claims he was a "young" man; it is possible that there was also an older man with walpu totem who is confused here); f.———; m.———; married Vf.4, Wf.6, Xf.12; 3 children, Y.3 (by Vf.4), Yf.4 (by Wf.6), Y.4 (by Xf.12), also Yf.3 is probably his daughter (by Sf.14).

Y.3. Tjodjongatjorongati burantant (bone fish); b. c. 1923; d. *c.* 1943; "just died"; not married; was dumb from birth; f. Y.2; m. Vf.4.

Y.4. Tawaringati bininj (mullet); white name Charlie Woollo; b. 2 October 1930 (date as given in Aurukun records, authority not evident); removed from Allen Island to Aurukun by police in April 1941; arrived at Mornington Island 1950; d. 1950 at Burketown, of encephalitis; not married; aged c. 20 years; f. X.4; m. Xf.12 (reason for dolnoro placing not established).

Y.5. Ngarangati banga (turtle) and/or tautamant (waterspout); white name Smiler; b. *c.* 1935 at Ngara on south side of Bentinck Island; arrived on Mornington Island from Allen Isand 2 July 1947; d. 10 July 1952; aged c. 17 years; f. Y.1; m. Wf.4; married Tf.13; 1 child, Yf.5 (born 13 months after father's death, but ascribed to him).

Y.6. Birarukingati tautamant (water spout); white name Billy; b. 1940; arrived on Mornington Island 18 October 1948; living June 1960; age 20 years; measured as BI. no. 13; not married; f. Y.1; m. Wf.4. Blood types:—B, Mss, R_1 R_0, P_1—, Le(a—), Fy(a+), K—.

Females of Dolnoro Y

Yf.1. BIRARUKINGATI bidjarupa (dugong); b. *c.* 1885; d. *c.* 1940; killed with a spear at Tjiltjadji on south side of Bentinck Island when her daughter Xf.15 and daughter's daughter Wf.8 were taken away to Allen Island by W.4; f.———; m.———; married X.2; 4 children, Xf.8, Xf.10, X.6, Xf.15 (by X.2).

Yf.2. BIRARUKINGATI kulkitji (shark); b. *c.* 1898; d. 1943; killed with spear at Markaruki by S.16, aided by S.15; aged *c.* 45 years; f.———; m.———; married Z.4; 4 children, Zf.2, Z.8, Zf.5, Zf.6 (by Z.4).

Yf.3. BIRARUKINGATI bidjarupa (dugong); white name ANNA; b. 1936; arrived on Mornington Island 4 August 1947; living June 1960; age 24 years; not married; no children; f. S.5; m. Sf.14. (Dolnoro positively identified; no explanation for difference from that of father.)

Yf.4. DJODJONGATJORO rurupururupu (black fish hawk); white name VALMAE; b. *c.* 1940 (was alive on 1 July 1941); arrived on Mornington Island 4 August 1947; living June 1960; age *c.* 20 years; not married; f. Y.2; m. Wf.; 1 child, Of.5 (by Colin Williams of Lardiil Tribe, Mornington Island).

Yf.5. ——— banga (turtle); white name SYBIL; b. 10 August 1953 at Mornington Island; living June 1960; age 6 years 10 months; f. supposedly Y.5 but child born 13 months after his death; m. Tf.13.

Males of Dolnoro Z

Z.1. Ngiltalngati; b. *c.* 1855; d. *c.* 1918; shot by white man who came in a boat from Sweers Island; ran away to top of sand hills at Berumoi and died; aged *c.* 63 years; f.———; m.———; 2 known children, Zf.1, Z.2.

Z.2. Dodjongapangati korpanggi (butterfish); b. c. 1880; d. c. 1930; speared in the throat during a fight on a saltpan at Tjapiluru by V.3; f. Z.1; m.———; married Tf.4 (widow of Z.3); no children (by Z.2).

Z.3. Markarukingati; b. c. 1890 or earlier; d. c. 1928; speared on a saltpan at Tjapiluru; f.———; m.———; married Tf.4; 5 children, T.8 (perhaps his stepchild only), Z.6, Z.7, Zf.3, Zf.4 (by Tf.4).

Z.4. Ngolotalkurunaijarupangati riningati (tiger shark); is said to have left dolnoro Z. and joined Y.; b. c. 1892; d. c. 1928; killed at Tjapiluru by S.7; aged c. 36 years; f.———; m.———; married Yf.2; 4 children, Zf.2, Z.8, Zf.5, Zf.6 (all by Yf.2).

Z.5. Dodjonapangati; b. c. 1920; d. c. 1946, of sickness of stomach; f.———; m.———; married Tf.4, widow of Z.3 and Z.2; no children; also had been promised Sf.23, who was drowned during a raft voyage to Allen Island in 1947.

Z.6. Bokanaijarupangati; b. c. 1921; d. c. 1944; aged c. 23 years; not married; f. Z.3; m. Tf.4.

Z.7. Ngiltalngati; b. c. 1923; d. c. 1945; aged c. 22 years; not married; with Z.8 was killer of S.9; f. Z.3; m. Tf.4.

Z.8. Danitjingati burantant (   ); b. c. 1918; d. 1947 (before June); killed by S.8; was killer of Uf.10 and jointly with Z.7 killer of S.9; unmarried; f. Z.4; m. Yf.2.

Z.9. Dodjododjongati (Dodjongapangati); b. c. 1927; d. 1948 of sickness of stomach; aged c. 20 years; just before his wife left the island in October 1948; f.———; m.———; was newly married to Tf.7 (widow of U.10) when he died; no children.

Females of Dolnoro Z

Zf.1. BILINAPANGATI bidjarupa (dugong); b. c. 1875; d. c. 1925 at Dolkalatji; aged c. 50 years; f. Z.1; m.———; married V.1; 4 children, V.2, Vf.2, V.3, Vf.6 (by V.1).

Zf.2. TONDOINGATI danuk (shark); white name THELMA; b. 1922; arrived on Mornington Island 4 August 1947; living June 1960; age 38 years; measured as BI. no. 27; f. Z.4; m. Yf.2; married unknown, then S.8, S.17; 2 children, Uf.20 (by ?), Sf.28 (by S.8). Blood types:—O, MNss, R_2 R_0, P_1—, Le(a−), Fy(a+), K—, Webb—.

Zf.3. DODJONGAPANGATI; b. c. 1925; d. c. 1942 at Dodjongapa; aged c. 16 years; not married; f. Z.3; m. Tf.4.

Zf.4. KALTURINGATI djolwaki (   ); white name DULCIE BOOTH; b. c. 1928 at Kalturi (in her stepfather's dolnoro); arrived on Mornington Island 4 August 1947; living June 1960; age c. 32 years; measured as BI. no. 25; f. Z.3; m. Tf.4; married S.18, received by S.17 but passed to T.12; 4 children, Tf.16, Tf.17, T.20, Tf.19; also two stillborn unsexed children, T.16 and T.18, prior to Tf.16. Note: This woman in one place was listed as of dolnoro U, but no check was made. Blood types:—O, MNss, R_1 R_0, P_1—, Le(a−), Fy(a+), K—, Webb—.

Zf.5. TARUKUNGATI dentjorara (salmon); b. c. 1930; d. c. 1944 of spear wounds inflicted at Parakuringki claypan apparently by S.8; aged c. 14 years; unmarried; f. Z.4; m. Yf.2.

Zf.6. DANGKAUKENAIJARUPANGATI (also called TJILIRUNGATI) walpu (raft); b. c. 1937; d. c. 1943; killed with a spear at Markaruki by S.15, shortly before he attacked and was killed by the R.A.A.F. man at Milt; aged c. 6 years; f. Z.4; m. Yf.2.

Male Whose Dolnoro is Unknown and Cannot be Assigned Because of Extra-Tribal Male Parentage

O.1. ————; white name Russell; b. 23 November 1953 at Mornington Island shortly after mother's arrival from Aurukun; living June 1960; age 6 years 6 months; f. Nigel Pootdemunka of Kendall River; m. Xf.15.

Females Whose Dolnoro is Unknown or Cannot be Assigned Because of Extra-tribal Origin of the Male Parent

Of.1. ————NGATI; white name MOLLY; b. *c.* 1918; arrived on Mornington Island 18 October 1948; d. 13 February 1949, cause of death not given; aged *c.* 31 years; f.———; m.———; married S.18; no children.

Of.2. MUNUKKA ANJUMBIN (name at Aurukun); white name BEATRICE; b. 10 November 1944; still living at Aurukun June 1960; age 15 years 6 months; not married; f. Edward Munukka Koondoombin of Aurukun; m. Wf.7.

Of.3. PAMPUTTA pulkududu (crocodile); white name ALMA; b. 20 July 1947 at Aurukun; arrived on Mornington Island September 1953; living June 1960; age 14 years 10 months; measured as BI. no. 39; f. Robert Kongnampa of Aurukun; m. Xf.15. Blood types:—O, MNss, R_1 R_1, P_1—, Le(a−), Fy(a+), K—, Webb—, Jk^a+.

Of.4. NDORNDORIN ANJUMBIN (name at Aurukun); white name DAWN, in some records incorrectly given as LORNA; b. 6 May 1948 at Aurukun; still living at Aurukun June 1960; age 12 years 1 month; f. Edward Munukka Koondoombin of Aurukun; m. Wf.7.

Of.5. ———— warung (goana); white name BETTY; b. 8 October 1958 at Mornington Island; living June 1960; age 1 year 7 months; f. Colin Williams, fullblood of Lardiil tribe, Mornington Island; m. Yf.4.

Persons who are not Kaiadilt, who have Married, or have had Marital Relationship with them

Extratribal 1. Robert Kongnampa of Aurukun; b.———; d. October 1948; married Xf.15 on 20 February 1946 at Aurukun; 1 child, Of.3 (by Xf.15).

Extratribal 2. Edward Munukka Koondoombin of Aurukun; b.———; living June 1960 at Aurukun; f.———; m.———; married Wf.7; 2 children, Of.2 and Of4 (by Wf.7).

Extratribal 3. Nigel Pootdemunka of Kendall River, Queensland; b.———; living June 1960 at Aurukun; 1 child, O.1 (by Xf.5).

Extratribal 4. Colin Williams; Lardiil tribe of Mornington Island; b.———; living June 1960 at Mornington Island; 1 child, Of.5 (by Yf.4).

Extratribal 5. IDA; Lardiil tribe of Mornington Island; b.———; living at Mornington Island June 1960; f.———; m.———; 1 child, Uf.23 (by U.15).

AUSTRALIAN QUAIL-THRUSHES OF THE GENUS CINCLOSOMA

By H. T. Condon, Curator of Birds, South Australian Museum

Summary

Quail-thrushes are a small Australian genus of Passerine birds (Family Timaliidae), of problematical affinities. The different species occur in a variety of habitats on the Australian continent, from the stony plains (gibber deserts) and semi-arid shrub communities of the interior to the drier woodlands and sclerophyll forests of the eastern coastal regions and Tasmania. Apparently in the early days of European settlement they were extremely numerous in certain places, but during the last one hundred years many forms have been extirpated from the more closely settled areas and wheat-growing districts in several States; others are now threatened by expanding economic development and habitat losses in all parts of the continent. Outside Australia the genus is represented by a single species in New Guinea, where it is widespread in the lowland forests (fig. 1).

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INTRODUCTION AND ACKNOWLEDGMENTS

Quail-thrushes are a small Australian genus of Passerine birds (Family Timaliidae), of problematical affinities. The different species occur in a variety of habitats on the Australian continent, from the stony plains (gibber deserts) and semi-arid shrub communities of the interior to the drier woodlands and sclerophyll forests of the eastern coastal regions and Tasmania. Apparently in the early days of European settlement they were extremely numerous in certain places, but during the last one hundred years many forms have been extirpated from the more closely settled areas and wheat-growing districts in several States; others are now threatened by expanding economic development and habitat losses in all parts of the continent. Outside Australia the genus is represented by a single species in New Guinea, where it is widespread in the lowland forests (fig. 1).

The quail-thrushes frequently are referred to as ground-thrushes, groundbirds, "rail babblers" (Gilliard, 1958) or "ground doves" (in Tasmania).

The Australian forms have been the subject of a careful study by A. J. and A. G. Campbell (1926). Unfortunately, no one museum

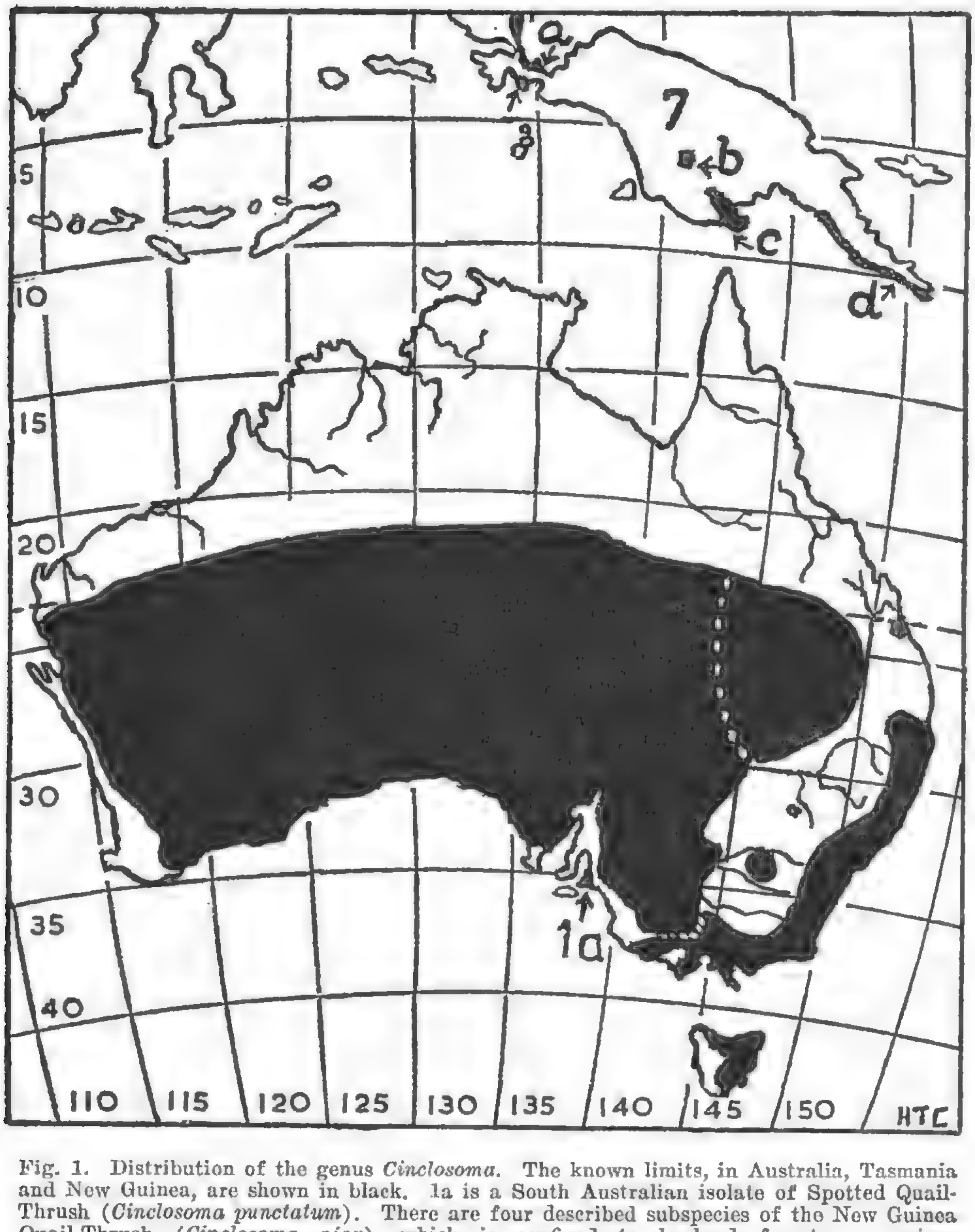

Fig. 1. Distribution of the genus *Cinclosoma*. The known limits, in Australia, Tasmania and New Guinea, are shown in black. 1a is a South Australian isolate of Spotted Quail-Thrush (*Cinclosoma punctatum*). There are four described subspecies of the New Guinea Quail-Thrush (*Cinclosoma ajax*), which is confined to lowland forests: a—*ajax*; b—*muscalis*; c—*alaris*; d—*goldei* (after Mayr, 1941).

possesses a representative series of all the known forms, among which are some of the rarest of birds. It is not surprising, therefore, that opinions are divided and much bewilderment exists regarding the taxonomy and nomenclature of the genus. Some consider that the work of the Campbells was indecisive (they refrained from using trinomials) and certain contradictory proposals have been put forward by G. M. Mathews and other writers. However, numerous specimens of the different forms have been taken during the last twenty-five years from new localities and a good deal more is now known, than formerly, about distribution and the morphological differences between the species.

The principal aim of this contribution is to add to the series of revisions of the genera of Australian birds, which have been commenced by Mayr, Serventy, Amadon, Keast, the author, and others (see Keast, 1961). To this end the writer has re-examined nearly all the specimens which were described in great detail by the Campbells (*loc. cit.*) and can vouch for the accuracy of their work. Fresh material has been compared in the museums in Adelaide, Brisbane, Melbourne, Perth and Sydney. Dr. Ernst Mayr has kindly supplied comments and measurements of specimens in the American Museum of Natural History and Dr. Allen Keast generously has made available his notes on the same collection, together with some details of specimens in the British Museum. Other information and comments have been received from Dr. D. L. Serventy and Messrs. N. J. Favaloro, W. B. Hitchcock, N. Jack, J. Jones, A. R. McGill, A. R. McEvey and G. Mack, to all of whom thanks are due. The conclusions reached in the text which follows are the writer's own. A. R. McGill's comprehensive Index to the first fifty volumes of *The Emu* has proved an invaluable aid to the work.

The Genus **Cinclosoma** Vigors and Horsfield 1827

Like many other Australian genera, *Cinclosoma* is of uncertain origin and relationships; and its position in any scheme of classification must be provisional. The genus is generally placed amongst the "babbling thrushes", or "babblers", family Timaliidae. The Australian *Official Checklist* (1926) follows Mathews (1921) and recognizes a separate family Cinclosomatidae—a procedure which has met with little acceptance.

Mayr and Amadon (1951), who have considered the question, iterate Hartert's view that the thrush-flycatcher group is a natural one and all these birds, which include the timaliids, should be placed in the family Muscicapidae. This course has been followed in the recommended sequence of Passerine families arrived at by an international committee (see Mayr and Greenway, 1956). Amadon (1957) has found it expedient to restore family rank to both the Timaliinae and the true thrushes (Turdinae). Presumably he would retain *Cinclosoma* in the Timaliidae, as favoured by Beecher (1955).

During a recent visit to Sydney, Mr. Keith Hindwood drew my attention to a South African species, *Chaetops frenatus,* the Cape Rock-Jumper, which bears a striking superficial resemblance to both the Australian and New Guinea species of *Cinclosoma*. Gill (1945) says "This remarkable bird and its two relatives are so difficult to place in any scheme of classification . . . they are now generally placed with the babblers, presumably on account of their long and strong legs. Their general bearing and actions are those of a thrush . . . The Cape species is found only on the mountains of the South-west Cape Province (excluding the Cape Peninsula) . . ." The coloured pictures in Gill and Roberts (1948) very strongly suggest a quail-thrush, and there may be some distant connection between the two genera (cf. Sharpe, 1903, p. 5).

Quail-thrushes are ground-frequenting birds, with skulking habits. They are about the size of a European thrush (*Turdus* sp.) that is, between 7½ and 10 inches (18-25.4 cm.) in length. Gould (1840), who preferred to call the birds "ground-thrushes", observed that "they differ more in habits and economy from the True Thrushes than their outward appearance indicates". Dorsal coloration is rufous in the desert forms and some shade of brown in all others. The broad rectrices are dark with prominent white tips, except the central pair, which are plain, frequently of the same colour as the back and, therefore, variable from one form to another. Plumage is soft and rather long, especially on the back, flanks and upper tail coverts. Wings are short and rounded; the tail is longer than the body and usually carried horizontally.

The tarsus is of medium length (*i.e.*, about twice the length of the bill), grey or nearly black in all the arid and semi-arid forms and either pale brown or flesh-coloured in the eastern coastal mainland and New Guinea species; it is scutellate in front and smooth and undivided on the plantar surface. The legs and feet are no larger or stronger than those of the average passerine.

The ratio of the lengths of the tarsus and wing ranges from 29 to 31 per cent in the Chestnut Quail-Thrush (all subspecies) and about 27 per cent in the Spotted Quail-Thrush; the values are somewhat higher in females. The bill, which in length exceeds its distance from the eye, is slightly curved, operculate and black in colour in both sexes of all the species.

The sexes are different and can be easily distinguished in adults, in the field and in the hand. For further discussion see below.

How far modern *Cinclosoma* has diverged from the remote ancestral stock it is impossible to judge. Mayr (1944) places the group to which the genus belongs in the second-oldest category of the Australian avifauna.

Doubtless, some form of sexual dimorphism was the condition in the immediate forebear of all the widely-dispersed, present day species.

The plumage pattern of young quail-thrushes is spotted and squamate, which suggests Turdine affinities.

Campbell (1926) refers to a small white "splash" on the outermost (tenth) primary of all species. This marking is, perhaps, the last remnant of an earlier and more ornate plumage pattern which might have been similar to that of the maculose bower-birds (*Chlamydera*), in which the tips of all the primaries, including the tenth, have a whitish splash.

It is of interest to record that the only other Australian passerine genus which has been found with a similar wing-marking is *Drymodes* (scrub-robin).

In the Southern Scrub-Robin (*Drymodes brunneopygia*), the wing splash occurs irregularly in males only and, together with other plumage markings on the head and wing coverts, seems to be in the process of being lost, for the evolutionary trend in this species has been clearly towards a more sombre coloration.

In the rufous Northern Scrub-Robin (*Drymodes superciliaris*) the same wing marking is found in both sexes, as in *Cinclosoma*.

The proper taxonomic relationship of *Drymodes* to *Cinclosoma* remains undecided, albeit the two genera are often placed close together in association with a few other genera, such as the New Guinea *Eupetes*. Young scrub-robins are very similar to young quail-thrushes. However, in adults, there are considerable size differences between the sexes in *Drymodes*, males being larger than females. Also, sexual dichromatism is not evident at any stage in the development of the scrub-robins.

Beecher (1953) does not mention *Drymodes*, but says "*Cinclosoma* and *Eupetes* are slender-billed narrow-skulled terrestrial forms with free lacrymal and, probably, forward vision; in them the pinnate character of M7b (one of the mandibular adductor muscles—H.T.C.) has virtually disappeared as it has in many honeyeaters and in the true wrens".

Mathews (1921), speaking of *Drymodes superciliaris* says: "Superficially this bird is closely related to *Cinclosoma* s. str., only differing in the longer legs, so that it appears to be a bush-loving form developed from a similar source".

Quail-thrushes are not songsters; they advertise their presence by uttering either short, harsh warning notes, a drawn-out, peevish monotone whistle, or "hissing". The birds are usually found in pairs or small family parties; they feed on insects and seeds (Lea and Gray, 1935). Like quails, they flush with a loud whirr of the wings and, after flying a short distance, they may either drop suddenly to cover and run before an intruder or take refuge on the limb of a tall tree.

The eggs, which are unmistakable in form and colour, are usually two or three in number; they are extremely thin-shelled, rather large, blunt, oval in shape, and mostly dull creamy-white, with dark frecklings and spots, which vary in coloration according to the locality and the species. The "carelessly constructed" nest of bark and grass is placed on the ground in the shelter of a low bush, tree trunk or other object.

Cinclosoma is a "natural" genus which may not be further subdivided as proposed by Mathews (1912) and Iredale (1956). Mathews separated the desert forms, with *cinnamomeum* as type, under "*Samuela*"; later he reduced this group to a subgenus in his *Working List* (1946). The minute differences, which Mathews quoted as "characters" of *Samuela*, are overshadowed by the more conservative features of plumage pattern and coloration which are common to all species. Iredale, whilst noting the similarity in plumage coloration of the New Guinea *C. ajax* to Australian forms, has advocated the adoption of the generic name *Ajax* Lesson on the grounds of "structural differences" in the bill and legs and different habits. However, the New Guinea species seems not too different to be regarded as a true quail-thrush (Sharpe, 1903; Mayr, 1941).

So far as known, the genus does not occur very far north of the Tropic of Capricorn on the mainland and it is unrecorded from any of the larger islands except Tasmania and New Guinea (fig. 1).

The distribution within Australia conforms to the prevailing pattern amongst sedentary birds in that it is a radial one. Each species of quail-thrush is confined to a particular habitat which is typified by the vegetation association; and, of course, the vegetation associations follow the climatic zonation (rainfall), which is concentric, with regularity. Discontinuities of the major habitats are reflected in the ranges of the birds, some of which are isolated simply by indentations of the coastline (fig. 3). Present day distributions can only be explained by changes in sea level and radial shifts of populations before increasing aridity (Condon, 1954: 18). Worldwide climatic change is believed to have caused alterations to vegetation patterns during and since late Pleistocene times (Specht, 1958), the result of which could have been the expansion of the ranges of the arid zone forms and the elimination of other members of the genus in the tropical north and other parts of the continent.

The Cinclosomatini have had, without doubt, a long evolutionary history in the Australian region. Mayr (1944) thinks that the group "probably reached Australo-Papua during early or middle Tertiary" times, roughly 35 million years ago, according to Holmes (1960). The separation of the desert forms would have coincided with the initiation of the climatic trends which led to the present zonation of vegetation, perhaps during successive arid periods in the Pliocene (Waterhouse, 1940).

The Spotted Quail-Thrush (*Cinclosoma punctatum*) is the oldest member of the genus in Australia. The presence of isolated populations in South Australia and elsewhere (fig. 1) suggests that it may have been widespread in former, more pluvial times. The remaining species in Australia seem to be later derivatives from a different stock more closely related to the New Guinea species. Keast (1961) notes that New Guinea, at its closet point, is only about 100 miles from Australia and that Torres Strait has been dry on several occasions during the Tertiary and Pleistocene.

As already indicated, allopatry is another feature of the genus, although *Cinclosoma cinnamomeum* and *Cinclosoma castanotum clarum* occur together in the same sector over a large portion of South Australia (fig. 2, 3, 4). However, there are differences in habitat preferences between the two (cf. Keast, 1958, for a similar situation in the genus *Amytornis*).

The species which has been recorded farthest north of the tropic of Capricorn is, rather surprisingly, the Cinnamon Quail-Thrush (fig. 2, nos. 103, 103A). It is thought that only one species occupies the great central desert region of Western Australia, from which ornithological observations are lacking; this is *Cinclosoma castanotum clarum,* the most distinct form of the Chestnut Quail-Thrush.

THE NUMBER OF SPECIES

On the basis of sexual dimorphism, other differences in plumage, and geographical distribution, it is suggested that the number of species remains the same as that proposed by Campbell (1926). These are:—

Cinclosoma ajax, New Guinea Quail-Thrush (four subspecies apud Mayr).

Cinclosoma punctatum, Spotted Quail-Thrush (with two subspecies).

Cinclosoma castanotum, Chestnut Quail-Thrush (five subspecies).

Cinclosoma alisteri, Nullarbor Quail-Thrush (no subspecies).

Cinclosoma cinnamomeum, Cinnamon Quail-Thrush (two subspecies).

Cinclosoma castaneothorax, Chestnut-breasted Quail-Thrush (no subspecies).

Cinclosoma marginatum, Western Quail-Thrush (two subspecies).

Several writers have proposed that the last four taxa listed above, which are all rufous-coloured, allopatric desert forms, are conspecific and that only three Australian species of *Cinclosoma* should be recognized. A few workers have united *C. alisteri* with *C. marginatum,* whilst others have preferred the arrangement in the Australian *Official Checklist* (1926), in which the last-named is combined with *C. castaneothorax.* Although at first sight this might appear to conform to modern ideas of taxonomic practice, it seems that the similarity in plumage coloration should be ascribed to convergence rather than to close relationship, for, as will be seen from the distribution map (fig. 2), there is no direct connection between *C. marginatum* and *C. castaneothorax,* which are on opposite sides of the continent. Furthermore, no evidence of intergradation has been observed between any of the rufous, desert-dwelling forms and the ranges of *C. cinnamomeum* and *C. alisteri* are contiguous in South Australia. So far as known, *C. marginatum* is not in contact with either *C. cinnamomeum* or *C. alisteri* (fig. 4).

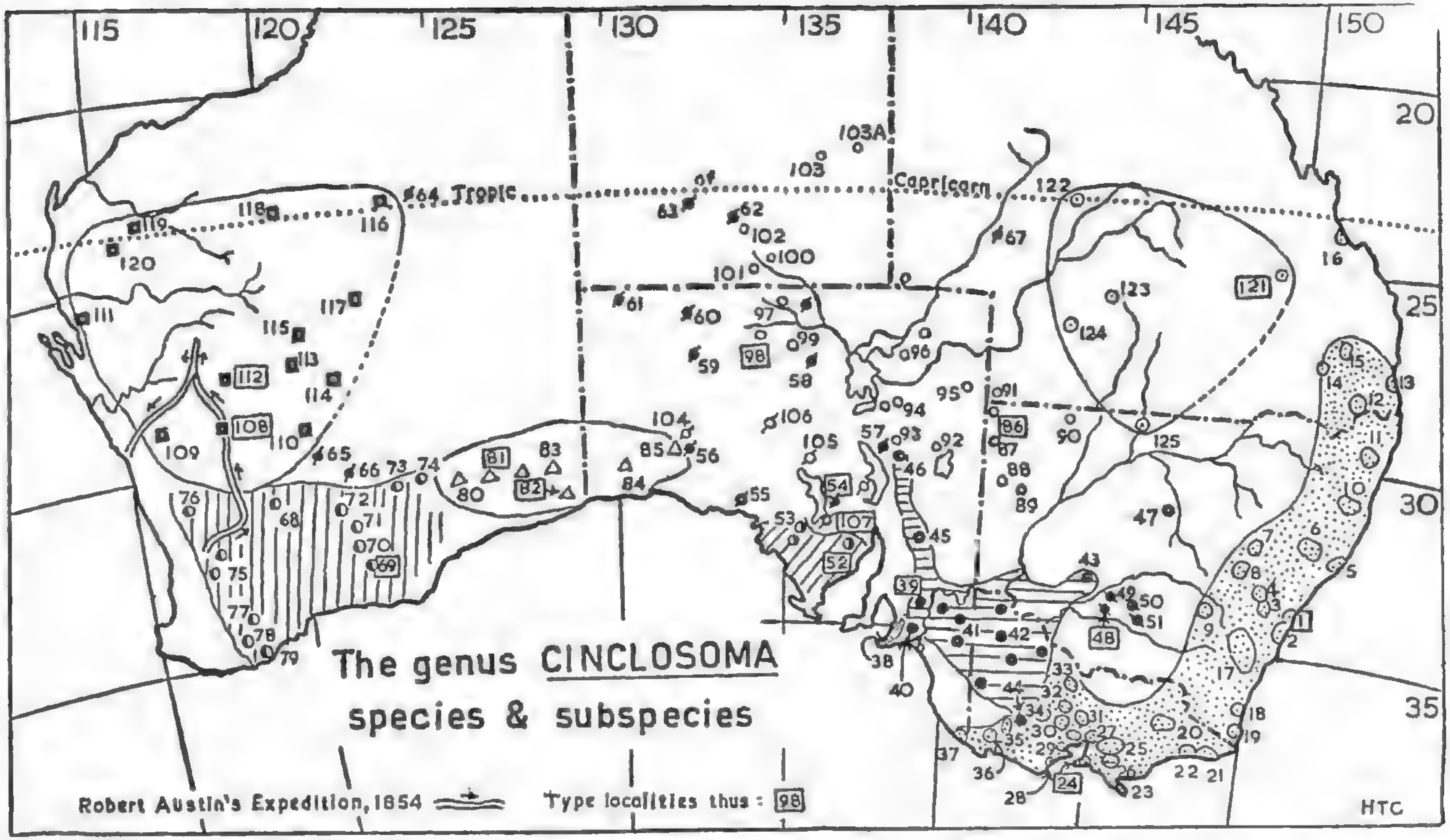

Fig. 2. Genus *Cinclosoma* in Australia. For place names see text. Nos. 1-38, Spotted Quail-Thrush, *C. p. punctatum*; 39-46, Chestnut Quail-Thrush, *C. c. castanotum;* 47, *C. c. castanotum* subsp.; 48-51, *C. c. mayri*; 52-53, *C. c. morgani*; 54-66, *C. c. clarum*; 67, *C. castanotum* subsp. (Parsons, 1921); 68-79, *C. c. dundasi*; 80-85, Nullarbor Quail-Thrush, *C. alisteri;* 86-103A, Cinnamon Quail-Thrush, *C. c. cinnamomeum*; 104-107, *C. c. samueli*; 108-110, Western Quail-Thrush, *C. m. marginatum*; 111-120, *C. m. nea*; 121-125, Chestnut-breasted Quail-Thrush, *C. castaneothorax.*

For those who insist that *C. alisteri* and *C. cinnamomeum* are conspecific, it may be pointed out that Hartert (1931) was quite uncertain on this question and referred to *C. alisteri* as "a very distinct form". Campbell (1926) remarked that *C. alisteri* "is at once distinguished from other 'tawny' species by the full black throat and breast" and listed the following "specific characters":—"(*a*) Small size and dark coloration. (*b*) Upper surface entirely plain, russet. (*c*) Brown stripe not continuous before the eye; lores entirely black. (*d*) White cheek stripe not reaching the gape. (*e*) Deep chestnut patch on each side of the breast". The Campbells also referred to the Nullarbor Quail-Thrush as "an offshoot from *castanotum*". Its young are certainly more like those of the latter species than *C. cinnamomeum*. Egg coloration, often a doubtful test, lends support to the view that *C. alisteri* is distinct. Two clutches in the South Australian Museum, taken at Haig, Western Australia and 40 miles south-west of Cook, South Australia, respectively, are heavily marked with light chocolate brown on a buffy white ground. These eggs show no great resemblance to those of either *C. cinnamomeum*, in which the frecklings are pale stone colour, or *C. castanotum*, in which the eggs are usually freckled with black. Also the normal clutch of *C. alisteri* appears to be three instead of two. H. L. White (1922) has referred to the ground colour in freshly taken eggs of *C. alisteri* as having "the least possible trace of greenish tinge".

SEXUAL DIFFERENCES

Sexual dichromatism is a feature of the genus. Nothing appears to be known regarding pair formation and display but doubtless the marked sexual dimorphism not only assists the members of a pair to find each other; it is also aposematic (Huxley, 1938). Howe, in Mathews (1921: 192) describes the excited actions of parent birds attempting to defend their young and the writer has observed a male of the Chestnut Quail-Thrush, with head feathers erect, wings drooping, and tail fanned, chase an intruder (scrub-robin). Plumage differences, which are strongly developed in adults and usually readily discernible in the young, follow a basic pattern in each sex. However, in no two species are the sexes exactly alike and the minor variations which are met with have obscured inter-specific relationships. Prominent white superciliary and malar stripes distinguish males in most cases and there is also much black on the face, ventral surfaces and wing coverts in all species, a feature which, almost invariably, is absent in females; these are much less boldly marked. Males have the wing coverts prominently spotted with white (except *C. ajax*); in females these spots are mostly buffy white.

At least one desert subspecies (*clarum*), of the widespread mallee frequenting species of *C. castanotum*, presents a bright rufous coloration dorsally in both sexes, which suggests that this colour might have been acquired independently on several occasions within the genus. This obvious adaptation to a desert environment, which involves a loss of melanin in the visible portions of the feathers, has been discussed by Meinertzhagen (1954, p. 9). It may afford some protection from the sun's rays by increasing the reflectivity of the plumage and additional "screen" protection from the sun is probably provided by the dark pigmentation of the concealed portions of the feathers, which, in *Cinclosoma*, as in many other unrelated desert forms, is considerably darker than in species living in temperate zones. This is well shown in the genus *Drymodes*, where the Northern tropical species, a rain-forest dweller, has rufous plumage of the "desert type", but the bases of the back feathers are not dark as in the inland form, *Drymodes brunneopygia*, which shows a slight amount of rufous on the rump.

There is a marked difference in the extent of rufous on the back in the sexes of the Chestnut-breasted Quail-Thrush (*C. castaneothorax*) of Queensland. In the male, the lower back and rump is rust-red, with the upper tail coverts and central rectrices fuscous; in the female, the scapulars and rump are rust-red with darker streaks and the upper tail coverts and central rectrices are brown. The female of the chestnut-breasted species is about the same size as the female of *C. castanotum* (nominate race) and at first sight could be mistaken for it. I have seen a female of *Cinclosoma castanotum clarum*, which is "red" on the back like *C. marginatum*, wrongly labelled as "*castaneothorax*".

The Nullarbor Quail-Thrush has the entire upper surface of the male, from forehead to tail, a bright rust-red, whilst in the female this colour is restricted to the scapulars, back and upper tail coverts, with the head and mantle cinnamon-brown. In the Chestnut Quail-Thrush, the amount of rufous or chestnut on the back is variable; in two forms it is most prominent in males and either reduced or completely absent in females. In another arid form of this species (*morgani*) it is equally developed in both sexes. Dorsal coloration in *C. cinnamomeum* is similar in both sexes.

Ventrally, there are important sexual differences in all species of *Cinclosoma*. Males are invariably black-throated; in *C. ajax*, *C. castanotum* and *C. alisteri* this coloration extends on to the upper breast. The greatest amount of spotting (black) on the flanks is found in males of *C. punctatum* (both sexes) and *C. ajax*; in other species the spots are reduced to streaks, and in *C. castaneothorax* the cinnamon-brown of the flanks is margined with a black line, somewhat as in *marginatum*. The flanks usually are not spotted in females. *Cinclosoma cinnamomeum* has the narrow whitish band, which separates the black of the throat and breast in males, sometimes tinged with rufous. This band disappears following wear and tear.

In the two rufous-breasted species, *C. castaneothorax* and *C. marginatum*, the breast is separated from the white abdomen by a narrow black line, which also borders the flanks, but in the lastnamed the flanks are of the same colour as the breast (bright cinnamon) whereas in *C. castaneothorax* the flanks are more brownish.

With the exception of *C. punctatum*, which is similarly spotted on the flanks in both sexes, no black appears on the flanks of females. In *C. punctatum* the upper breast is grey in males and females. The throat and breast are greyish in females of *C. castanotum*, *C. alisteri* and *C. cinnamomeum* and more rufous in the two remaining species. In females the centre of the abdomen and lower breast is white in all species, although the extent of white in *C. castaneothorax* is much less than in either *C. marginatum* or *C. cinnamomeum* and more as in *C. castanotum*.

The reduction of the superciliary stripe, which is buff in the male of the Chestnut-breasted Quail-Thrush, and the incorporation of the malar stripe in the light-coloured throat of the female in this species, perhaps indicates a trend towards the condition found in New Guinea birds (*C. ajax*), where the eyebrow is entirely absent in the male and the throat and malar stripe (white) are merged in the female. As already mentioned, there are distinct differences in the markings of the head, face and throat in the different species (plates 12, 13) and these may be used to separate them in the field and, more especially, in the hand (see the key). Males have red irides; in females these are brown except in *C. punctatum*, where the colour is grey.

It is probable that all the forms of *Cinclosoma* are vicarious, but I have been unable to find any real reason why the more or less ecologically similar desert-dwelling species should be lumped together under one species.

KEY TO THE SPECIES

Males (all have black throat when fully adult).

1.	No superciliary stripe; wing coverts and alula black, unspotted	*ajax*
	Superciliary stripe present; wing coverts and alula black with white spots	2
2.	Throat black, sharply defined from the breast	3
	Throat and upper breast black	4
3.	Breast grey, a large white malar patch	*punctatum*
	Breast rufous, a white malar stripe extending from near the gape	6
4.	A whitish band on the foreneck, which separates the black of the throat and upper breast (see text)	*cinnamomeum*
	Foreneck black	5
5.	Sides of breast grey, white malar stripe	*castanotum*
	Sides of breast chestnut, an enlarged white malar stripe	*alisteri*
6.	Superciliary stripe white	*marginatum*
	Superciliary stripe buff	*castaneothorax*

Females (the throat is never black).

1.	Coloration of throat and malar region uniform	2
	Malar region distinct from throat	3
2.	Throat and malar region white	*ajax*
	Throat and malar region orange-buff	6
3.	Breast grey; a large orange-buff malar patch	*punctatum*
	Breast grey; a malar stripe extending from near the gape	4
4.	Throat pale; malar stripe orange-buff; breast fawn grey	*cinnamomeum*
	Throat same shade as breast, grey	5
5.	A white malar stripe	*castanotum*
	An enlarged white malar stripe	*alisteri*
6.	Superciliary stripe buffy-white; breast deep cinnamon	*marginatum*
	Superciliary stripe pale orange-buff; breast pale brown	*castaneothorax*

SYSTEMATIC TREATMENT

1. **Cinclosoma punctatum** (Shaw) 1795
(Spotted Quail-Thrush)

The Spotted Quail-Thrush is a denizen of the drier sclerophyll forests of the highlands of eastern and southern Australia and Tasmania (fig. 2). It is a declining species which has been wiped out in many districts following the destruction of its natural habitat. A set of two eggs in the South Australian Museum (Malcolm Murray collection), labelled "near Mt. Gambier. Dr. Morgan, November 11, 1898", is the only evidence that the species may have once occurred in that part of South Australia. In the southern Mount Lofty Ranges the Spotted Quail-Thrush, unlike much of the indigenous fauna, has found a temporary haven in some of the government-owned pine forests, where its future is uncertain. But wherever the native vegetation remains undisturbed the birds occur in fair numbers and there is little doubt that they were very numerous in the early days of settlement on the mainland as well as Tasmania, where they were often killed for food.

The species shares with *C. ajax*, of New Guinea, the distinction of having flesh-coloured or pale brown legs and feet.

Judging from the eggs, the nesting record of *C. castaneothorax* from Gladstone, Queensland by Barnard (1900), should be referred here. The Spotted Quail-Thrush is "still a well-known bird on the Darling Downs" (A. C. Cameron, *in litt.*, January, 1962).

(a) **Cinclosoma punctatum punctatum** (Shaw) 1795

Turdus punctatum Shaw 1795. *Zool. Nov. Holl.*, 3, pl. 9. New South Wales.

Synonym: *neglectum* Mathews 1912. Frankston, Victoria.

Range: Southern Queensland from Gladstone (?), Bunya Mountains and the Brisbane area south to coastal New South Wales (as far inland as Grenfell) and Victoria (north to beyond Bendigo) and westwards towards the Glenelg River district in suitable localities; extinct in many districts. In South Australia, confined to parts of the Mount Lofty Ranges; probably extinct in the Mount Gambier district. Not on Kangaroo Island.

Diagnosis: Grey breast band margined with black in male only. General coloration and size variable and similar to the Tasmanian form. Wing—Males, 111-112 (Queensland), 113-120 (New South Wales), 103-115 (Victoria), 105, 114 (South Australia); females, 108-

111 (Queensland), 104-115 (New South Wales), 106, 112 (Victoria). 102-111 (South Australia). Tarsus—30. Bill—16-17 mm.

Bill black, iris grey, legs and feet pale brown (male); bill black, iris grey with a tinge of lilac, inside mouth orange, legs and feet pale brown (female).

Judging from variation in wing measurements, which is probably clinal, the largest birds of both sexes come from New South Wales. It has not been established that the members of the relict Mount Lofty population are smaller than those from Victoria, as suggested by Campbell (1926), but it is thought that they may differ in having more grey on the wings.

Mathews (1912) introduced the name *neglectum* for Victorian birds, saying "differs from *C. p. punctatum* in its darker coloration, but paler than *C. p. dovei*". According to Hartert (1931), the type was an adult female from Frankston, Victoria, taken on March 13, 1909. The name *neglectum* was dropped by its author from his Working List (1946) and has been rejected by most other workers.

Localities: (see fig. 2, Nos. 1-38). 1. Sydney (type locality; 2. Port Hacking and National Park area; 3. Colo River; 4. Lithgow; 5. Lake Wallis area; 6. Barrington Tops; 7. Cobbora; 8. Wellington district; 9. Grenfell; 10. Upper reaches of Macleay River; 11. Copmanhurst (North, 1904, p. 325); 12. Emu Vale and Warwick (specimens, American Museum); 13. Brisbane (specimens, Queensland Museum); 14. Darling Downs (eggs, *Emu*, p. 63); 15. Bunya Mountains (specimens, American Museum); 16. Gladstone (Barnard, 1900); 17. Goulburn-Braidwood district; 18. Bega district; 19. Wonboyn (Favaloro); 20. Buffalo Mountains; 21 Mallacoota (S. A. White); 22. Marlo (Bryant); 23. Wilson Promontory; 24. Mornington Peninsula (Frankston) (type locality, *neglectum* Mathews); 25. Gippsland; 26. Lang Lang; 27. Mitcham-Ringwood area; 28. Anglesea (Purnell, *Emu*, 15: 41); 29. near Geelong; 30. Ballarat (specimen); 31. Gisborne-Macedon area; 32. Castlemaine; 33. North of Bendigo (Hitchcock, pers. comm.); 34. Pyrenees Mountains, near Ararat; 35. Grampians; 36. Hotspur; 37. Mount Gambier (eggs, South Australian Museum); 38. Mount Lofty Ranges.

Other localities not shown on map: New South Wales:—Between Bermagui and Tathra (Edwards); Lockwood; Mount Irvine; Wolgan (specimens). Victoria:—A. Gippsland and eastern Victoria; north of Buchan (specimen); Deddich road, near Gelantipy (specimen); Drouin (Batey); Glenaroua; Hazelwood (specimens); Mount

Cobbler, 4,500 feet (Cole); Mount William, near Lancefield (Batey); Merriman Creek (Ingle); Nyora; Reeves River; Tambo River (specimens); Taujil River and Ranges (Ford); Sheep Station Point, Gippsland lakes; Yinnar (specimens). B. West and north of Melbourne:—Dog Rocks, near Geelong (Hill); Toolern Vale (30 miles west of Melbourne) (Campbell); You Yangs (Bird Observers Club).

South Australia (Mount Lofty Ranges): near Adelaide; Ambleside; Basket Range; Belair; Blackwood; Blakiston; Bridgewater; Cape Jervis; Chain-of-Ponds; Eden Hills; Encounter Bay; Kuitpo; Lobethal; Meadows; Mitcham; Mount Lofty; Teatree Gully; Upper Sturt; Uraidla (specimens and/or observations in each case).

(b) **Cinclosoma punctatum dovei** Mathews 1912

Cinclosoma punctatum dovei Mathews 1912. *Nov. Zool.*, 18, p. 330. Tasmania.

Range: Tasmania.

Diagnosis: The male differs from the mainland bird in being, usually, more greyish on the head and back. There is a black margin to the grey breast band in both sexes. The abdomen, in females, is pure white. Wing—"Males, 107-111; females, 102, 109" (E. Mayr). Tarsus—31. Bill—16 mm.

Some of the differences to be found in Tasmanian birds were first recognized by Campbell (1926) and they have been confirmed by examination of material in the Mathews collection in New York by Drs. Mayr and Keast. As pointed out by Hartert (1931), in size *dovei* falls within the range of the mainland form. Referring to Mathews' description of the type ("smaller and darker"), Hartert notes that it has no original label and that a second specimen in Mathews' collection is not "darker" than mainland examples. Actually, plumage coloration is variable, some birds being more greyish above than others. Also the throat of the female may be either mottled greyish or buffy-white.

Howe (1931) stated that the eggs of Tasmanian birds are "rather larger" than those from the mainland; also that the clutch "often" consists of three or four eggs, perhaps even five. Campbell (1900) referred to reports of large clutch sizes; see also Littler (1910). Sharland (1958), who gives the clutch size as two to three, considers that the Spotted Quail-Thrush is "a diminishing species in southern Tasmania and does not appear to be common anywhere" for which he blames the domestic cat. Littler (1910) says ". . . in no locality is it as plentiful as it was before the country was opened up . . .", when it was "extremely plentiful" and sold in the markets as a food delicacy.

Localities: (not shown on map, fig. 2). Cullenswood; Freycinet Peninsula; Hobart; Mount Wellington; Sandford; Wilmot; near Koonya and Impression Bay.

2. **Cinclosoma castanotum** Gould 1840

(Chestnut Quail-Thrush)

The Chestnut Quail-Thrush, which is confined to the southern half of Australia, is the most widely-distributed of all the species of *Cinclosoma* (fig. 3) and shows the greatest geographical divergence. It does not occur in localities with an annual rainfall of more than 30 inches. In the northern parts of its range the natural habitat is arid scrub, with eucalypts in the minority, whilst in the south the habitat is semi-arid or sclerophyll mallee, with *Eucalyptus* species predominating.

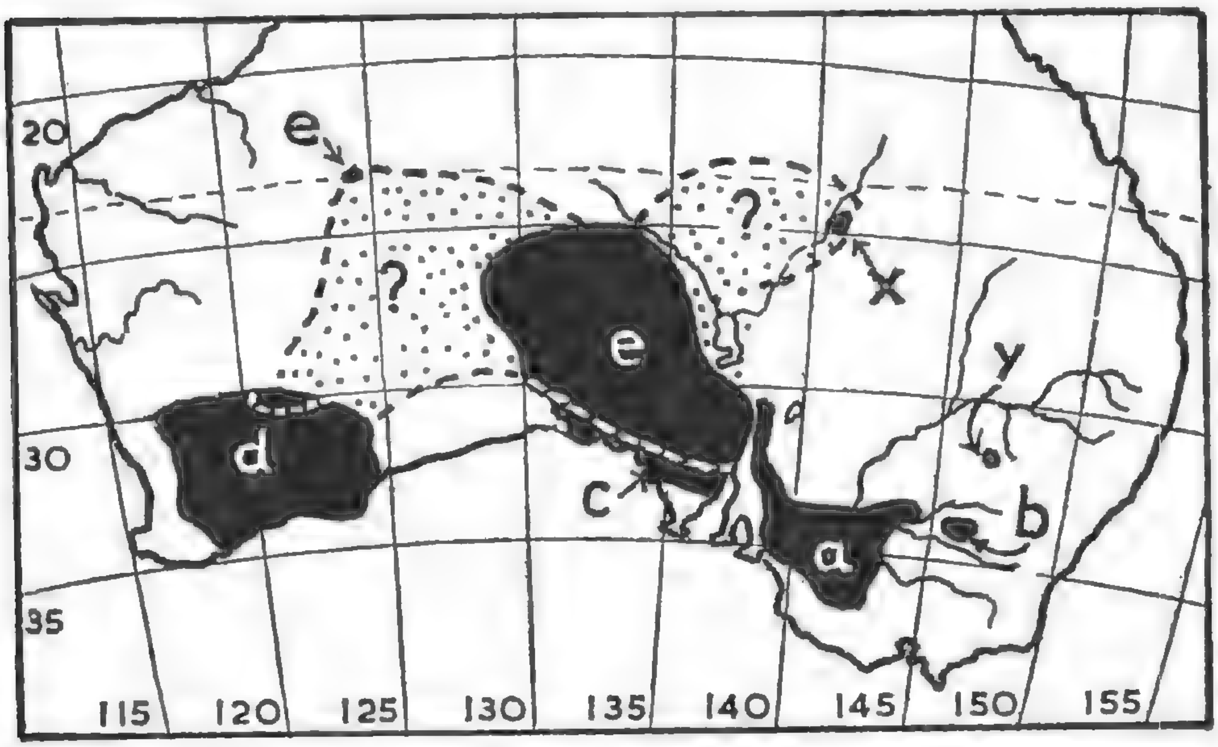

Fig. 3. Distribution of Chestnut Quail-Thrush, *Cinclosoma castanotum*. The subspecies are: a—*castanotum*; b—*mayri*; c—*morgani*; d—*dundasi*; e—*clarum*. Stippled areas = probable range, from which no specimens have been taken. Note that *C. c. clarum* overlaps the geographical range of *C. cinnamomeum* (cf. fig. 4). x = subsp. (?) (Parsons, 1921); y = subsp. (?) (Keast, pers. comm., 1959).

Keast (pers. comm.) observed the Chestnut Quail-Thrush at Nymagee (fig. 2, No. 47; fig. 3, y) near the northernmost extension of the mallee in New South Wales, but failed to obtain a specimen.

Like the preceding species, *Cinclosoma castanotum* has been driven from much of its former habitat in the wheat-growing districts and its range and numbers must continue to diminish.

The following subspecies, some of which are isolates, may be distinguished:

A. Dark chestnut rump in male (greatly reduced or absent in female):

(*a*) Size small, general coloration olive brown	*castanotum*
(*b*) Size larger, general coloration darker . . .	*mayri* nov.

B. Chestnut rump brighter and more extensive:

(*c*) Coloration of rump equally developed in both sexes	*morgani*
(*d*) Coloration of rump reduced or absent in females	*dundasi*
(*e*) Back, scapulars, rump and portion of upper tail coverts light chestnut and equally developed in both sexes	*clarum*

(a) Cinclosoma castanotum castanotum Gould 1840

Cinclosoma castanotum Gould 1840. Birds Austr., part 1, Dec. 1. Belts of the Murray, South Australia.

Range: Semi-arid Mallee districts of south-eastern South Australia (as far north as Leigh Creek) and adjacent parts of New South Wales (east to about Mossgiel) and north-western Victoria (south to Ironbark Ranges) (Howe, 1909), and south of Ararat (Hill, 1907).

Diagnosis: Olive brown above (greyish) with a dark chestnut band (40 mm. maximum width) restricted to the rump in males and absent or greatly reduced in females and young birds. Flanks brown. Ear coverts olive brown.

Measurements: Wing—Males, 98-105; females, 95-103. Tail—Males, 94-99; females, 95-98. Tarsus—28. Bill—13-16 mm.

Gould's cotypes, which are housed in the Academy of Natural Sciences of Philadelphia, were obtained east of the Mount Lofty highlands in Mallee scrub near the River Murray in the direction of Morgan. De Schauensee (1957) says "Gould's plate shows a male and a female, the male being a particularly richly coloured individual, with which the type agrees". He gives the following measurements: "Adult male, wing 105, tail 94; adult female, wing 98; culmen 16".

Campbells' description (1926) of a male from Karoonda, South Australia (B516), which they call a "plesiotype", fits most individuals of this race.

A specimen in the Australian Museum, Sydney (O.18077) bears the label "Adelaide, 1864", which is questionable.

Localities: (see fig. 2, Nos. 39-46). 39. Belts of the Murray River (type locality); 40. Chauncey's Line; 41. Pinnaroo area; 42. Mossgiel; 43. Ouyen; 44. near Ararat (*Emu*, 44: 190); 45. Oodlawirra; Leigh Creek (specimens).

Other localities, not shown on map:—Victoria—Antwerp (near Jeparit; between Hattah and Kulkyne; Ironbark Ranges (near Stawell) (*Emu*, 8: 135); Kow Plains; Lake Boga; Nhill; Panitya; Pine Plains; Red Cliffs; Turriff; Wyperfield.

South Australia—Alawoona; Bowhill (specimen); Copley; Flinders Ranges near Lake Frome (*S. Austr. Orn.*, 4: 73); Loxton; between Murray Bridge and Karoonda (*ibid.*, 10: 32); Mannum; Paringa; Patsy Springs (Copley) (eggs); Renmark area (*ibid.*, 5: 72); Sutherlands; Taplan; between Truro and Blanchetown; Turner Well.

(b) **Cinclosoma castanotum mayri** subsp. nov.

Type locality: 20 miles south of Rankin Springs, New South Wales. Type: Australian Museum No. O 39745; adult male. Allotype: Australian Museum No. O 39688; adult female.

Diagnosis: Larger and darker than the nominate form. Adult male:—Crown, ear coverts and dorsal surfaces olive brown, without a greyish tinge; chestnut rump 47 mm. wide (against 40 mm. in *castanotum*); white malar stripe 40 mm. long (against 30 mm. in *castanotum*); extent of black from chin to lower breast 80 mm. (in *castanotum* this does not exceed 52 mm.). Flanks reddish brown. Wing, 107; tail, 112; tarsus, 31; bill, 17 mm. "Gonads developing; no surplus fat; stomach contents seeds and insect remains" (collector's label). Fresh plumage. Collector, J. A. Keast, September 15, 1957. Adult female:—Large. Dorsal coloration similar to male, except for rump, which is tinged with dark chestnut only; malar stripe well developed. Wing, 100; tail, 99; tarsus, 30; bill, 16 mm. "Stomach contents, seeds." Fresh plumage. Collector, H. J. Frith, April 8, 1955. Locality, 27 miles north of Griffith, New South Wales.

The presence of the Chestnut Quail-Thrush in some scattered belts of Mallee scrub in the Murrumbidgee Irrigation area of New South Wales has long been known (Emerson and Gannon, 1934; Chisholm, 1938). Rather surprisingly, specimens collected have proved to be almost as large in body size as the Spotted Quail-Thrush; the population is, of course, an isolate.

Localities: (see fig. 2, Nos. 48-51). 48. Rankin Springs (type locality); 49. Griffith; 50. Barellan (*Emu*, 37: 307); Leeton (*ibid.* 22: 311). Also 36 miles north of Narrandera (Chisholm).

(c) **Cinclosoma castanotum morgani** Condon 1951

Cinclosoma castanotum morgani Condon 1951. *S. Austr. Orn.*, 20, p. 42. 18 m. north-west of Kimba, South Australia.

Range: Eyre Peninsula, South Australia. Probably extinct in many localities.

Diagnosis: Upper back (mantle) olive brown. Lower back, rump and portion of the upper tail coverts bright chestnut and equally developed in both sexes. Ear coverts olive brown. Wing—Males, 102, 105; females, 92, 97. Bill, 18. Tarsus, 30 mm.

In size and coloration this geographical variant, which is mentioned by Campbell (1926) and Morgan (1926), is intermediate between *clarum* and nominate *castanotum*. Like *clarum*, it is exceptional in having the male and female similarly coloured on the upper surface, but the chestnut on the back is less extensive (47 mm. wide). The type, a breeding male, is in the South Australian Museum (No. B 5673).

Localities: (see fig. 2, Nos. 52-53). 52. 18 m. north-west of Kimba (type locality); Gawler Ranges area (specimens).

(d) **Cinclosoma castanotum dundasi** Mathews 1912

Cinclosoma castanotum dundasi Mathews 1912. *Nov. Zool.*, 18, p. 330. Lake Dundas, Western Australia.

Range: South-western Australia ("north to the mulga-eucalypt line . . . but excluding the heavy forested area" (Serventy and Whittell, 1951). Probably extinct in a number of localities.

Diagnosis: The male resembles *morgani*, with the chestnut rump about 47 mm. wide, but differs in having a shorter bill and longer tarsus. Female is dull-coloured, the rump being either tinged with chestnut (in the more easterly parts of the range) or plain. Ear coverts olive brown. Wing—Males, 97-101; females, 95-99. Tarsus, 34. Bill, 12-15 mm.

The type, which is in the Mathews collection, was collected by F. L. Whitlock, at an altitude of 850 feet, on July 16, 1905; Mathews' figure (1921, pl. 424) is hardly recognizable. A topotypical male, taken by Dr. D. L. Serventy at a place 10 miles south of Widgiemooltha, near Lake Dundas, on March 22, 1937, has been examined. Details of specimen: "Iris, port-wine red; feet lead grey. Length, 250; head 47; wing 98; tail 105 mm." (Serventy/Whittell collection, No. 746).

Most authors accept *dundasi;* some have suggested that *clarum* (below) should be included with it. Further collecting in the western part of its range may show clinal differences with the trend, in the western parts of the range, towards a darker chestnut rump.

The habitat is mainly semi-arid scrub (Mallee), but it may include areas of temperate woodland.

Localities: (see fig. 2, Nos. 68-79). 68. North of Southern Cross; 69. Lake Dundas (type locality); 70. near Norseman; 71. Widgiemooltha (specimens); 72. Coolgardie (*Emu*, 27: 180); 73. 80 m. east of Kalgoorlie (*ibid.*, 10: 70); 74. near Nullarbor Plain; 75. Parker Range; Dwaladine; Woyaline (*Ibis*, 3 (ser. 9): 683) (specimens); 76. Wongan Hills; 77. Broome Hill; 78. Cranbrook; 79. Albany (specimens). Specimens from other localities not shown on map:—Gracefield; Woryantilla; Mongup (Salt River); 53 m. from Fremantle (on York road) (Gould).

(e) **Cinclosoma castanotum clarum** Morgan 1926

Cinclosoma castanotum clarum Morgan 1926. *S. Austr. Orn.*, 8. p. 138. Wipipippee rocks, near Lake Gairdner, South Australia.

Range: From the MacDonnell Ranges, Northern Territory westwards to Separation Well, Callion, and north of Kalgoorlie, Western Australia; Musgrave and Everard Ranges south to about Lake Gairdner, South Australia.

Diagnosis: The most brightly coloured of all the forms of *castanotum*. The back, scapulars, rump, and portion of the upper tail coverts are light chestnut ("burnt sienna") in both sexes. The white tips of the wing coverts are enlarged. Ear coverts blackish in the male. Examples from the northern parts of the range are more tawny on the flanks. Wing—Males, 98-102; females, 97-102. Tarsus, 30. Bill, 19 mm.

Specimens of *clarum* have now been taken from such widely separated localities as Lake Gairdner, Everard and Macdonnell Ranges and north of Kalgoorlie. There is a specimen in the Australian Museum which was collected by the Horn Expedition at Deering Creek, Northern Territory and another, a female, from Callion, Western Australia in the Queensland Museum (No. 06768). A further skin, from near Ooldea is contained in the National Museum of Victoria (No. R9574).

The type, a male, was collected by Dr. A. M. Morgan at a spot about 5 miles east of the southern end of Lake Gairdner on August 17, 1905; it is housed in the South Australian Museum, No. B7705. An adult pair was taken by R. Williams at a place between the Musgrave and Everard Ranges, South Australia, in September, 1926. Other records which can be referred to *clarum* are from Edward Creek (Simpson, 1933), Myrtle Springs, South Australia (Cain, 1935) and near Separation Well, North-west Australia (Keartland, in North, 1909). Whitlock (1910), knowing nothing of this rufous form of *C. castanotum*, which was not described until sixteen years later, suggested that Keartland met with *C. marginatum*, not *C. castanotum*, at Separation Well. However, although the latter's specimens were lost before he returned to civilization, there is no reason to doubt his identification.

Females should not be confused with those of any other desert species; the foreneck and throat, as in all forms of *C. castanotum*, is grey.

The habitat of *clarum* differs from that of other subspecies of *C. castanotum*, being an arid Mulga scrub formation, rather than Mallee. In northern South Australia, the range of *clarum* overlaps that of the Cinnamon Quail-Thrush (see figs. 3, 4), but the latter is restricted mainly to open stony (gibber) country and in the strictest sense should not be regarded as sympatric with *clarum*. In Western Australia the ranges of *clarum* and *marginatum* are probably contiguous, and, depending on the nature of the terrain and vegetation, the occurrence of the former may be limited to "pockets" of trees and taller shrubs within the central desert areas of Western Australia from which, as yet, no member of the genus has been collected or reported.

Localities: (see fig. 2, Nos. 54-67). South Australia. 54. Wipipippee Rocks (type locality); 55. near Ceduna (*S. Austr. Orn.*, 9: 144); 55. Ooldea (specimen); 57. Myrtle Springs (*S. Austr. Orn.*, 13:

10); 58. Edward Creek (*ibid.*, 12: 129); 59. Everard Ranges (*ibid.*, 17: 6); 60. Officer Creek (eggs) (*Emu*, 15: 35); 61. between Musgrave and Mann Ranges (specimens); 62. Hermannsburg (Horn Expedition); Deering Creek (specimen) (Horn Expedition). Western Australia. 64. Separation Well (*Trans. Roy Soc. S. Austr.*, 22: 180); 65. near Menzies (North, 1: 326); 66. north of Kalgoorlie (specimen). Queensland. 67. Diamantina Gates (identity uncertain (Parsons, *S. Austr. Orn.*, 6: 20).

3. **Cinclosoma alisteri** Mathews 1910
(Nullarbor Quail-Thrush)

Cinclosoma alisteri Mathews 1910. *Bull. Brit. Orn. Cl.*, 27, p. 160. Waddilinia, Nullarbor Plain, Western Australia.

Synonym: *nullarborensis* Campbell 1922. Haig and Naretha, Western Australia.

Range: Nullarbor Plain, Western and South Australia (fig. 4).

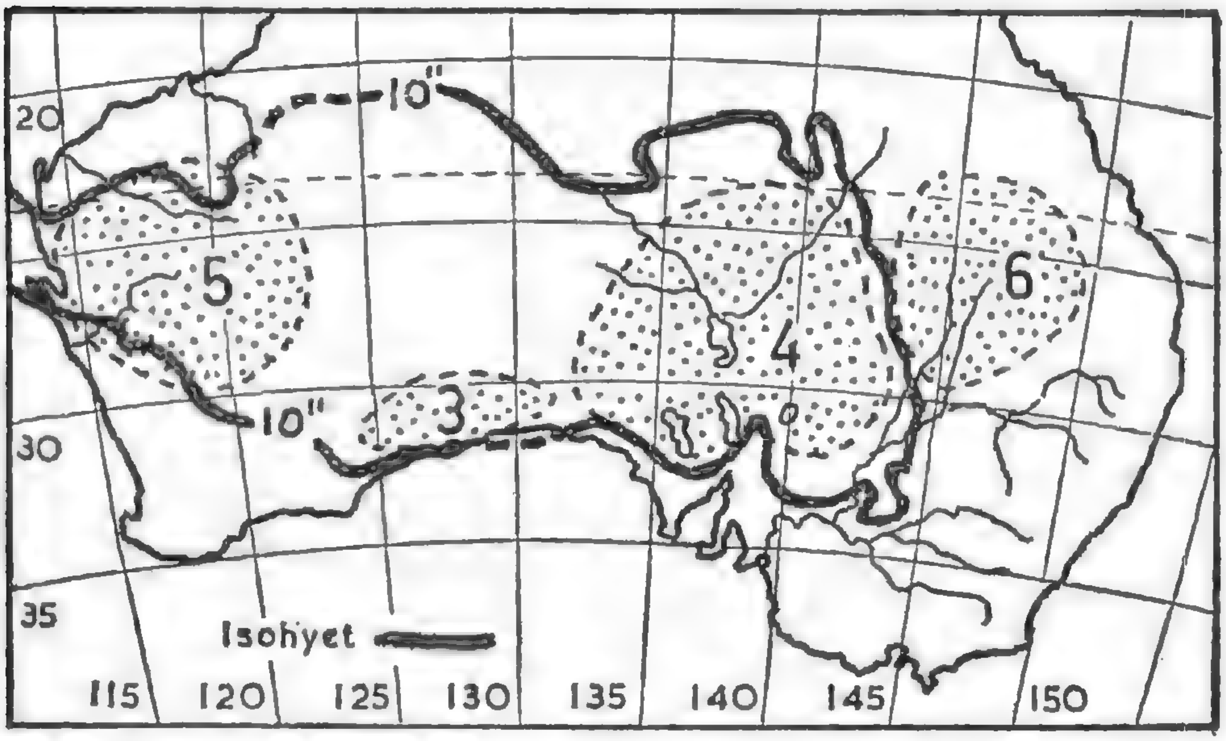

Fig. 4. Distribution of the arid species of *Cinclosoma*. 3, Nullarbor Quail-Thrush, *C. alisteri*, which is confined to the shrub steppe region known as the Nullarbor Plain; 4, Cinnamon Quail-Thrush, *C. cinnamomeum*, in the areas of lowest rainfall, the environment being arid grasslands and stony (gibber) deserts; 5, Western Qail-Thrush, *C. marginatum*, in a region isolated from the other forms; 6, Chestnut-breasted Quail-Thrush, *C. castaneothorax*, which lives in open scrublands. Note that all, except the last-named, are contained within the 10-inch annual isohyet.

Diagnosis: The entire upper surfaces, including the central rectrices, are rich rufous ("auburn" or "russet") in the adult male, which has the ear coverts, throat, and breast black. The adult female is duller rufous on the head and back, the superciliary and malar stripes are whitish, and the ear coverts, throat, and breast are grey. In both sexes the under tail coverts are buff, spotted with dark brown. Juvenals are dull rufous above and the feathers of the breast have dusky or blackish edgings which become more intense with age, in males.

Measurements: Wing—Male, 81-92; male juv., 78; female, 85, 86. Tarsus—Male, 28; juv., 24; female, 25. Bill—16 (adult); 14 mm. (male juv.).

The Nullarbor Quail-Thrush is a rarity in collections. There is a small series, of about seven skins, in the H. L. White collection (National Museum of Victoria), two skins in the Australian Museum, Sydney, and three males in the Mathews collection (American Museum of Natural History). There are no specimens in the South Australian Museum. It is worth while emphasizing that *C. alisteri*, which has no subspecies, is a much deeper rufous bird than *C. cinnamomeum*, with the markings of the throat and breast, in both sexes, more as in *C. castanotum*.

Localities: (see fig. 2, Nos. 80-85). 80. Waddilinia (type locality); 81. Haig (type of *nullarborensis* Campbell); 82. Loongana; 83. Forrest; 84. 40 miles S.W. of Cook (eggs); 85. Ooldea. Not shown on map:—Naretha.

4. **Cinclosoma cinnamomeum** Gould 1846
(Cinnamon Quail-Thrush)

The Cinnamon Quail-Thrush lives in the stony (gibber) deserts and sandhill country of Central Australia, where the annual rainfall is less than 10 inches (fig. 4). The geographical range extends further north and south than shown in the map by Campbell (1926). This is a variable species, both in size and coloration, and two subspecies may be recognized.

(a) **Cinclosoma cinnamomeum cinnamomeum** Gould 1846

Cinclosoma cinnamomeum Gould 1846. *Proc. Zool. Soc.*, London, p. 68. Sturt's Depot, north-western New South Wales.

Synonym: *todmordeni* Mathews, 1923. Todmorden, South Australia.

Range: Eastern desert regions of lower Northern Territory (extending to just above the Tropic of Capricorn) far south-western Queensland, far north-western corner of New South Wales, and northern South Australia south to about Lake Torrens, Lake Frome and the vicinity of Leigh Creek.

Diagnosis: Larger in body-size (not shown by wing and tail measurements). Head more greyish than the back; ear coverts dark greyish brown. Wing—Males, 85-90; females, 81-87. Tarsus, 28. Bill, 16 mm.

Females are usually paler than males with the wing coverts brownish black with prominent white tips. The female figured by Mathews (1921, pl. 426) is a specimen from near the Macumba River, South Australia. Young birds have the feathers edged with black, forming crescents, especially on the under surface. Abrasion causes some variation in the plumage pattern of males. Birds from near the centre of the range, separated as *todmordeni* by Mathews, are often palest (caused by fading and wear), but light and dark individuals have been examined from the same locality. Specimens from Todmorden, Oodnadatta, Birdsville and Lake Frome are indistingushable in most instances.

Of special interest is a specimen taken for the Northern Territory Administration by Mr. W. B. Hitchcock, on May 9, 1955; the locality was "19 miles east of Cockroach W.H., Jervois S. R.". The specimen, an immature male, is temporarily housed in the National Museum of Victoria. Details from the collector's label are:—"Male, skull n.f.o.; iris warm sepia; moult-legs; humeral (slight). On road and on stony ground in *Acacia georginae* and *Cassia* sp. community". This represents the northernmost record of the genus in Australia, although previously (1949), the late L. J. Ellis took a set of two eggs of a species he was unable to identify in rocky country in the Jervois Range, Northern Territory, at a spot south-west of Cockroach W.H.

Localities: (see fig. 2, Nos. 86-104). 86. Sturt Depot (type locality); 87. Mount Arrowsmith; 88. Lake Bancannia; 89. west of Wilcannia; 90. west of Paroo River; 91. Naryilco Station; 92. Lake Frome; 93. Leigh Creek; 94. north of Marree; 95. Murturee, Strzelecki Creek; 96. Mirramitta; 97. Blood's Creek; 98. Todmorden (type locality of *todmordeni*); 99. near Oodnadatta; 100. Horseshoe Bend; 101. Crown Point; 102. near Hermannsburg; 103. Jervois Range; 103A. 19 m. E. of Cockroach W.H., Jervois S.R. (Hitchcock); 104. Ooldea (specimen).

(b) **Cinclosoma cinnamomeum samueli** (Mathews) 1916

Samuela cinnamomea samueli Mathews 1916. *Austral Av. Rec.*, 3, p. 60. Gawler Ranges, South Australia.

Range: South-west of Lake Eyre, extending through Stuart Range to Ooldea and the Gawler Ranges.

Diagnosis: Cinnamon coloration brighter and more intense; the crown and ear coverts have a rufous wash and the amount of white on the band separating the black breast and throat is somewhat reduced. Wing—Males, 85-90; females, 80-85. Tarsus, 27. Bill, 15 mm.

It has not been possible to determine exactly the northern limits of *samueli*. Probably it does not extend beyond a line drawn from Stuart Range to the northern shores of Lake Torrens. The type, a male in the Mathews collection, came from Sandford's paddock, a holding in the Gawler Ranges; it was taken on September 3, 1912, by S. A. White.

Hartert (1931) correctly points out that this form has nothing to do with the North-western Australian form *C. marginatum*, which Mathews calls "*nea*" in his 1931 List. *Samueli* can be distinguished by its small body size and greater amount of rufous coloration on the crown and ear coverts; it can in no way be confused with *castaneothorax*, from Queensland, with which Hartert was inclined to unite it. Material examined suggests that females may have more grey on the throat than those of the nominate form, but occasional examples are met with the throat pale buffy white. The general coloration, in both sexes, is more rufous, or of a deeper shade, than in the northern race, not "paler" as stated by Mathews, whose type was "very worn and in poor condition" (Hartert, *loc. cit.*).

Localities: (see fig. 2, Nos. 105-107). 105. Mount Eba; 106. Stuart Range; 107. Gawler Ranges (type locality of *samueli*).

5. **Cinclosoma marginatum** Sharpe 1883

(Western Quail-Thrush)

The Western Quail-Thrush occupies the Mulga scrubs of the huge pastoral area of North-western Australia, its range, so far as known, extending from just north of the Tropic of Capricorn southwards to the agricultural areas and eastwards towards the sand dune desert country where hummock-forming xeromorphic grasses (*Triodia*, etc.) predominate (fig. 4, No. 5).

Much confusion has arisen regarding the correct name for this form of *Cinclosoma* following Mathews' decision (1927) to treat *C. marginatum* and *C. cinnamomeum* as conspecific. Previously the former had been combined with *C. castaneothorax* (see Australian *Official Checklist*, 1926). Making an erroneous assumption, Mathews suppressed the name *marginatum* Sharpe and substituted for it instead one of his earlier names, *nea*. He argued, correctly, that Elsey, whom Sharpe had named as the collector of the type of *C. marginatum*, had never been in Western Australia and then went on to propose "North-west New South Wales" as the type locality for *C. marginatum*. In doing so, he ignored an entry in the British Museum register which stated that Sharpe's type was "from an Australian Expedition, probably Mr. Austin's, W. Austr.".

Robert Austin was a surveyor who arrived in Western Australia in 1840. Four years later he made a trip via lakes Cowcowing and Austin to the upper reaches of the Murchison and then proceeded to Geraldton. The route of this expedition is shown on early published maps of Western Australia (*e.g.*, Philip's Handy General Atlas of the World, 1882). Austin returned with a small collection of bird skins for the British Museum. Among them were two skins of *Cinclosoma*, collected in the vicinity of Mount Kenneth, 70 miles south of Mount Magnet (Whittell, 1954); the type locality of Sharpe's *C. marginatum* should be amended accordingly.

The inland form of *C. marginatum* is smaller and paler than the bird described by Sharpe, and Mathews' name, *nea*, is available for it.

Unfortunately, Hartert (1931) treated *nea* as a form of *C. cinnamomeum* and the true situation has been further obscured by Whittell and Serventy (1948), who have rejected both *marginatum* and *nea*, employing instead the name *castaneothorax* (type locality "South Queensland") as a subspecific designation in combination with *Cinclosoma cinnamomeum* for birds from North-western Australia. This course has recently been followed by Lindgren (1961) whose reference to the "Cinnamon Quail-Thrush" at Jigalong (Lat. 23 deg. 24 min. S., Long. 120 deg. 46 min. E.) should, of course, be applied to the Western Quail-Thrush.

As pointed out by Gentilli (1961) the habitat of *C. marginatum* has suffered great changes owing to overgrazing by sheep and the plant cover "in some places has been almost wiped out". Thus it seems that, like other members of the genus, *C. marginatum* will have little opportunity to adapt itself to the new conditions imposed by man.

(a) **Cinclosoma marginatum marginatum** Sharpe 1883

Cinclosoma marginatum Sharpe 1883. Cat. Bds., Brit. Mus., 7, p. 336. Type locality, amended herein, Mount Kenneth, Western Australia.

Range: Coastal regions from about the Tropic of Capricorn, extending to south-east of the Murchison River, within the 10-inch rainfall belt, Western Australia.

Diagnosis: Males have a bright rufous (cinnamon) breast band, dark brown ear coverts and a well-defined dark crown. The eyebrow is white and the breast and flanks are bordered with black. The under tail coverts are black edged with white. The back rump, central rectrices and flanks are bright rufous in both sexes.

Females have a dark crown, brown ear coverts, the throat, superciliary stripe and malar region deep buff, the back is streaked darker, and there is very little white on the rufous abdomen. The under tail coverts are reddish-brown tipped with white, with a narrow subterminal black band.

Wing—Males, 91, 97; female, 97. Tail—Male, 95; female, 101. Tarsus, 29-31. Bill, 14.

Localities: (see fig. 2, Nos. 108-110). 108. Mount Kenneth (type locality); 109. near Yalgoo; 110, Mount Ida.

(b) **Cinclosoma marginatum nea** Mathews 1912

Cinclosoma castaneothorax nea Mathews 1912. *Nov. Zool.,* 18, p. 331. Day Dawn, Western Australia.

Range: North-western Australia (inland).

Diagnosis: Smaller and paler than the preceding form. Ear coverts rufous, lores brownish in the female. Wing—Males, 91-92; females, 81-91. Tarsus, 27. Bill, 15 mm.

There is little doubt that specimens from the lower rainfall regions of North-western Australia can be separated from those nearer the coast and this is borne out by descriptions published by Mathews, Campbell and other writers. Day Dawn, the type locality of *nea,* is about 50 miles north of Mount Magnet. Further material may indicate that the variation in this species is clinal, in which case some authors may prefer to drop *nea* altogether.

A small female, taken at Carnarvon, has the ear coverts brownish instead of rufous and could be referred to either form.

Localities: (see fig. 2, Nos. 111-120). 111. Carnarvon; 112. Day Dawn (type locality); 113. Wiluna (*Emu*, 9: 196); 114. Lake Darlot; 115-116. Canning Stock Route (specimens); 117. Brockman Creek (Calvert Expedition); 118. Jigalong (*W. Austr. Nat.*, 7: 114); 119 Wanery River; 120. Barlee Range.

6. **Cinclosoma castaneothorax** Gould 1849
(Chestnut-breasted Quail-Thrush)

Cinclosoma castaneothorax Gould 1849. *Proc. Zool. Soc.*, London, 1848: 139, pl. 6. Near the Dawson River, Queensland.

Range: Interior of southern Queensland and adjacent areas in New South Wales.

Diagnosis: In the male there is a glossy black throat; rich rust-red breast band edged with black; eyebrow buff; the rump and back are deep rust-red. The female has the throat and malar region orange-buff and the eyebrow is of the same colour. The breast, which is pale brown, merges into the dull cinnamon-brown of the flanks. There is no black on the under surface of the female, which has the back olive-brown and the rump reddish-brown, with indistinct darker streaks.

Bowdler Sharpe (1881) pointed out that Gould's name for this species, being a "vox hybrida", should be amended to "*erythrothorax*", but the altered spelling has never been used. In Gould's original description it was stated "Hab. Darling Downs, New South Wales" and this has been quoted generally as the type locality. However, it seems certain that the type, a male, was taken by Charles Coxen at a place north of the Darling Downs not far from where Gilbert, when collecting for Gould, saw some birds in the Valley of Ruined Castles, near the upper reaches of the Dawson River, Queensland (Chisholm, 1945) (see fig. 2, No. 121).

Only four specimens have been taken of this little known species, viz. (*a*) Gould's type, acquired by the British Museum, and, I am informed, now missing; (*b*) an adult male, collected by F. L. Berney, at Barcarolle, Thomson River, Queensland, September 4, 1925 and now in the Queensland Museum (O 3501). This bird has been described by Campbell (1926) and described and figured by Mathews (1928, pl. 44). (*c*) An adult female (South Australian Museum, No. B 21432), collected by Dr. W. MacGillivray, Adavale-Charleville road, August 27, 1923. It has been figured by Mathews (1928, pl. 44). (*d*) An adult male, taken in *Thryptomene* heath scrub country at Enngonia (near Bourke), New South Wales, September, 1960 (National

Museum of Victoria, No. B7383). Eggs were also taken near the same place in 1959.

Measurements: Type male (adapted from Gould)—Total length, 212. Wing, 100. Tail, 106. Tarsus, 25. Bill, 25 (?). Male (Berney's specimen)—Wing, 99. Tail, 105, Tarsus, 27. Bill, 14. Male (Enngonia)—Wing, 99. Tail (worn), 102. Tarsus, 28. Bill, 14. Adult female—Wing, 98. Tail, 96. Tarsus, 28. Bill, 15 mm. The male preserved in the National Museum of Victoria had a black bill and grey legs.

Gould's type was figured with the original description (1849) and a different illustration of the same bird was given in the "Supplement to the Birds of Australia" (1855, pl. 32). A further illustration of the type was supplied by Mathews (1936, pl. 70, left hand figure). It would seem that the accompanying descriptions given by Mathews at this time, wherein *C. castaneothorax* and *C. marginatum* are compared, became transposed by the printer. The male in the Queensland Museum, which is the same specimen as described by Campbell (1926), now bears the date May 20, 1926 instead of the proper date "September 4, 1925". Cameron (1932, 1938) reported seeing the species at Quilpie and Moombidary Station (Hungerford), Queensland and more recently near Bourke, New South Wales.

The Chestnut-breasted Quail-Thrush was combined with *C. marginatum* in the Australian *Checklist* (1926) because there is a superficial resemblance between the males of the two species. Of late, especially among those who have not examined specimens, the tendency has been to regard both *C. marginatum* and *C. castaneothorax* as forms of *C. cinnamomeum*. The male from Enngonia, in which the plumage is fairly fresh, is darker on the back than the specimen taken by Berney. The sternum has been preserved.

A. R. McEvey has written, "In the H. L. White collection is a set of two eggs labelled *C. castaneothorax*—taken by H. Lau, Darling Downs, Queensland, October, 1888 (see *Emu*, 8: 63). These are distinct from others labelled *marginatum alisteri* and *castanotum*. Though smaller than those of *punctatum*, they are clearly of the *punctatum* type, having a white ground colour sparingly speckled with very small umber, mauve and purple spots". The writer agrees that these eggs are probably *punctatum*.

Localities: (see fig. 2, Nos. 121-124). Near Upper Dawson River (type locality). 122. Barcarolle, Thomson River. 123. Adavale-Charleville road. 124. Quilpie. 125. Enngonia.

7. **Cinclosoma ajax** (Temminck) 1835
(New Guinea Quail-Thrush)

Eupetes ajax Temminck 1835. *Planch. Col. d'Ois.*, pl. 573. Lobo, Triton Bay, South-west New Guinea.

Range: New Guinea (lowland forests).

Iredale (1956) does not regard this species as a true quail-thrush, which it seems to be in every way. The male differs from all other members of the genus in lacking a white eyebrow and in having no white on the black wing coverts. The differences between the sexes are more marked than in any Australian species. The adult female has a white eyebrow, the throat and malar region are pure white (merged), and the wing coverts are nearly black or brown, according to the subspecies, with prominent white markings. In size *Cinclosoma ajax* approaches *C. punctatum* of the Australian mainland, being approximately 9½ inches (242 mm.) in length.

The following is a synopsis of the subspecies listed by Mayr (1941):—

(*a*) *Cinclosoma ajax ajax* (Temminck) 1835. Triton Bay, New Guinea. Larger and darker brown above than the following, with the lores and postocular stripes black. Wing—"Male, 114; female, 109, 110".

Range: Western coast of Geelvink Bay and Triton Bay.

(*b*) *Cinclosoma ajax muscalis* Rand 1940. Palmer Junction, upper Fly River, south New Guinea. Resembles *ajax* above, with the flanks and sides of the breast much paler and less vividly coloured. Wing—"Male, 108, 110".

Range: Upper Fly River, south New Guinea.

(*c*) *Cinclosoma ajax alaris* Mayr and Rand 1935. Wuroi, Oriomo River, south New Guinea. Known only from the female, which is larger and more deeply rufous above than the female of *goldei*, with the wing coverts more brownish.

(*d*) *Cinclosoma ajax goldei* (Ramsay) 1879. Port Moresby, New Guinea. Smaller and paler olive brown above than the nominate form. Wing—"Male, 103, 104". Two males, which are similar to that figured by Iredale (1956), are contained in the Australian Museum, Sydney.

Range: Milne Bay to Hall Sound, south-eastern New Guinea.

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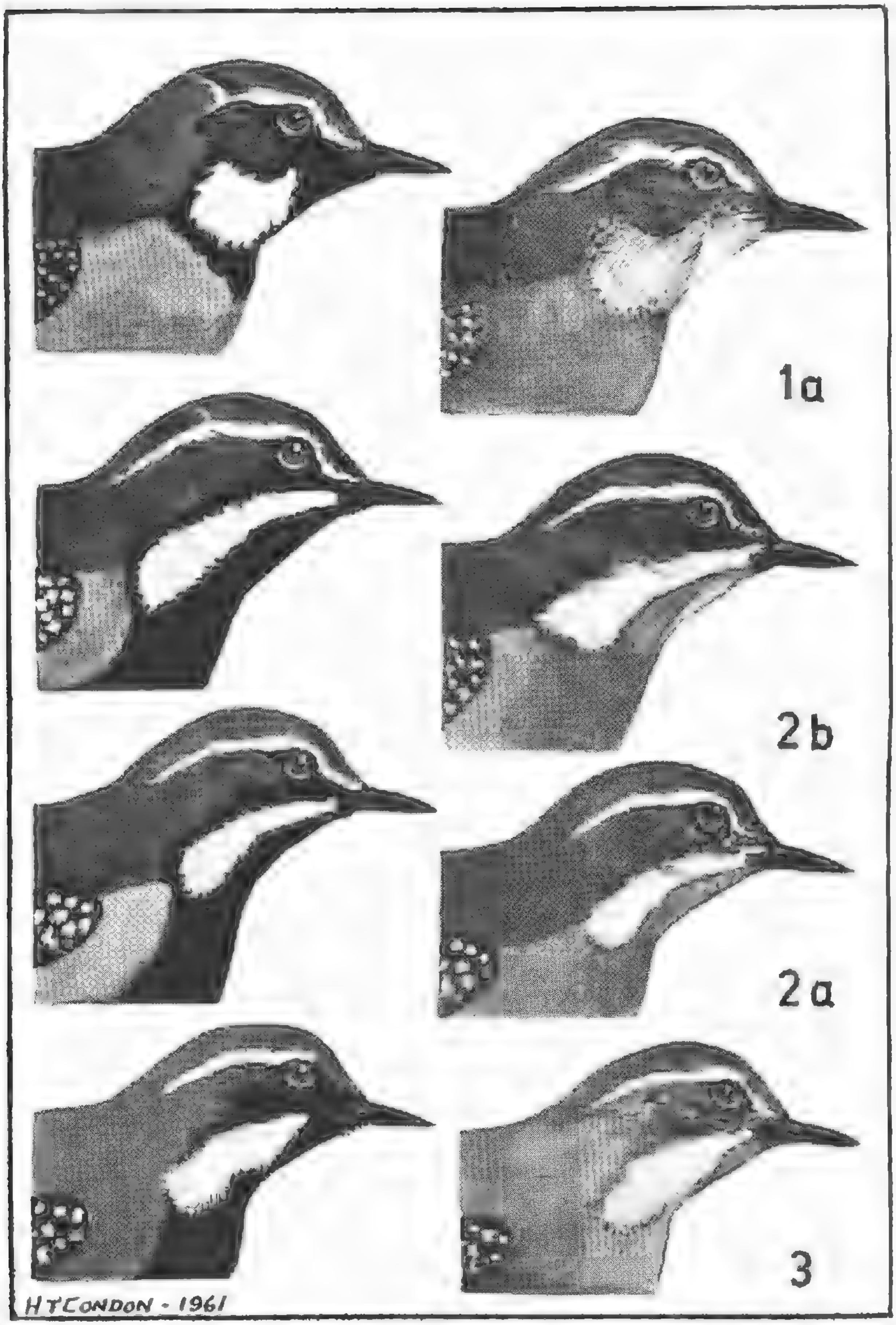
DESCRIPTION OF PLATES 12-13

Plate 12. Genus *Cinclosoma.* Heads of adult pairs, males on left. 1a, Spotted Quail-Thrush, *Cinclosoma punctatum punctatum*; 2a, Chestnut Quail-Thrush, *Cinclosoma castanotum castanotum*; 2b, *Cinclosoma castanotum mayri*; 3, Nullarbor Quail-Thrush, *Cinclosoma alisteri.*

Plate 13. Genus *Cinclosoma.* Heads of adult pairs, males on left. 4a, Cinnamon Quail-Thrush, *Cinclosoma cinnamomeum cinnamomeum*; 5, Western Quail-Thrush, *Cinclosoma marginatum marginatum*; 6, Chestnut-breasted Quail-Thrush, *Cinclosoma castaneothorax*; 7, New Guinea Quail-Thrush, *Cinclosoma ajax ajax.*



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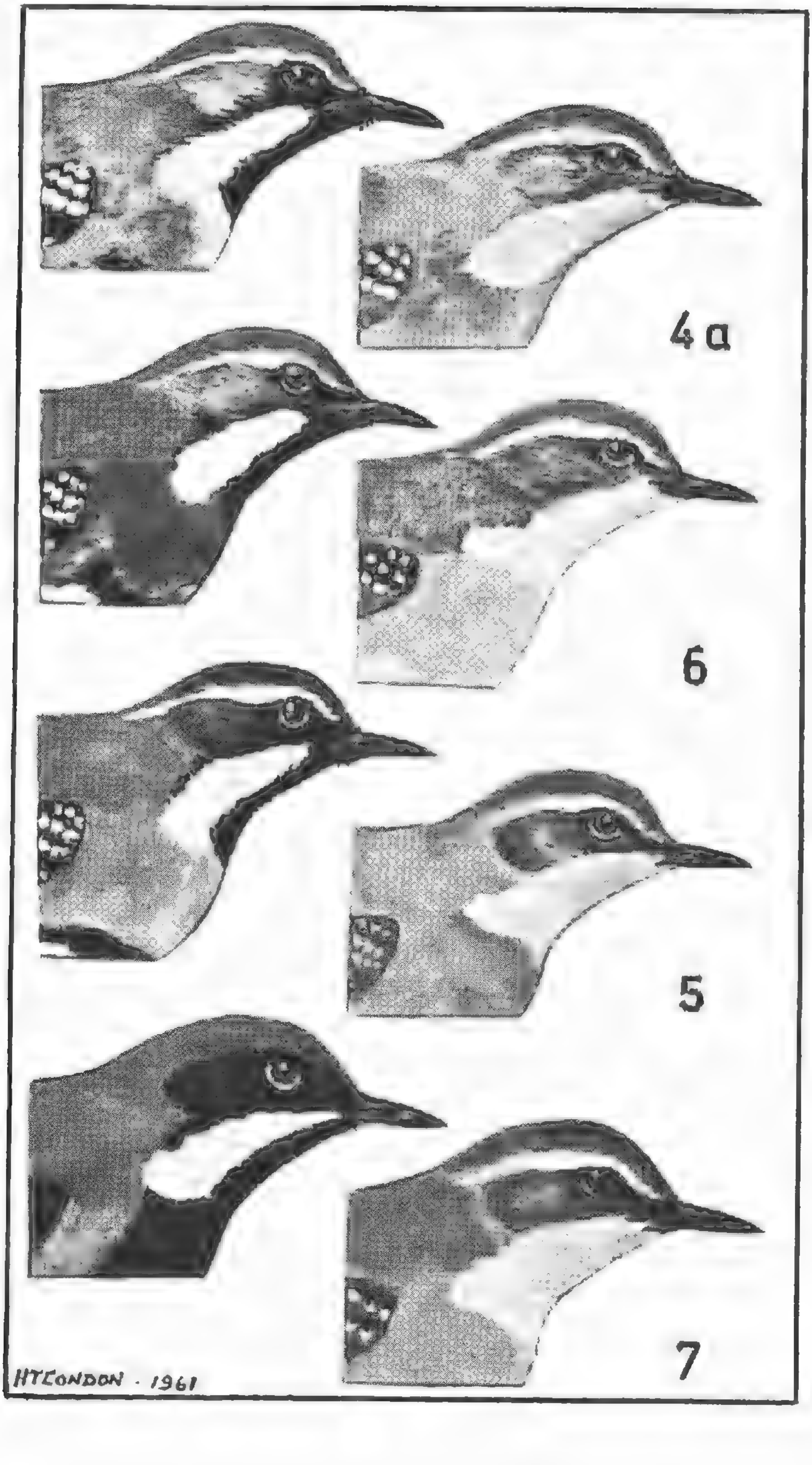
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ABERRANT AUSTRALIAN BRACHYPTEROUS MYODOCHINE BUGS (LYGAEIDAE, RHYPAROCHROMINAE)

BY GORDON F. GROSS, CURATOR OF INSECTS, SOUTH AUSTRALIAN MUSEUM

Summary

This paper deals with the systematics of a predominantly brachypterous group of rather specialized Australian bugs of the Lygaeid tribe Myodochini. Three new genera are erected and fourteen species of the Australian fauna discussed. Five of the species are new and some synonymy of the others is proposed.

ABERRANT AUSTRALIAN BRACHYPTEROUS MYODOCHINE BUGS (LYGAEIDAE, RHYPAROCHROMINAE)

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Plates 14-16

SUMMARY

This paper deals with the systematics of a predominantly brachypterous group of rather specialized Australian bugs of the Lygaeid tribe Myodochini. Three new genera are erected and fourteen species of the Australian fauna discussed. Five of the species are new and some synonymy of the others is proposed.

ACKNOWLEDGMENTS

This paper was made useful through the unstinting help of Mr. G. G. E. Scudder of the University of British Columbia, Vancouver and of Dr. T. E. Woodward of the University of Queensland. The latter, when in England, took the trouble to examine all available and relevant type material. Mr. Scudder supplied much useful criticism at the generic level. I am indebted to the Directors and Boards of Trustees of the National Museum, Melbourne, the Australian Museum, Sydney, the British Museum, the Naturhistoriska Riksmuseet, Stockholm, the Waite Agricultural Research Institute, Adelaide, and the Division of Entomology C.S.I.R.O. Canberra, for loans of material, freely made to Mr. Scudder, Dr. Woodward, and myself.

ABBREVIATIONS

The following abbreviations are used in citing the location of material. S.A.M.—South Australian Museum, Adelaide; N.M.—National Museum, Melbourne; A.M.—Australian Museum, Sydney; C.S.I.R.O.—Division of Entomology, C.S.I.R.O., Canberra; W.A.R.I.—Waite Agricultural Research Institute, Adelaide; B.M.—British Museum (Nat. Hist.), London; R.M.S.—Riksmuseet, Stockholm.

INTRODUCTION

Classification of the subfamily Rhyparochrominae on the tribal and subtribal level has always presented considerable difficulties, and several markedly different schemes have been proposed. Stål (1872) divided the subfamily into six divisions—Myodocharia, Rhyparochromaria, Beosaria, Gonianotaria, Lethoearia and Drymaria, then again in 1874 placed the subfamily in five divisions—Cleradaria, Myodocharia, Rhyparochromaria, Beosaria and Lethoearia. Distant (1903) recognized the first three of Stål's 1874 divisions, but lumped the last two into the group Aphanaria.

Gulde (1934) added two other tribes to these of Stål (1874), Pterometini and Stygnocorini. Scudder (1957) found the characters used up to that time to be rather unreliable and based a new classification on the position of the trichobothria and spiracles, together with the spermathecae. He divided the subfamily into four tribes, Rhyparochromini, Lethaeini, Drymini, and Stygnocorini. He further subdivided the Rhyparochromini into three subtribes Gonianotina, Rhyparochromina, and Plociomerina. Slater (1957) suggested the names for the Rhyparochrominae and Rhyparochromini should be Megalonotinae and Megalonotini, but this has been shown to be incorrect.

Slater and Sweet (1961) and Sweet and Slater (1961) raised the number of tribes to eight, retaining Scudder's (and others') concept of Lethaeini and Drymini but splitting his Stygnocorini into Cleradini and Plinthisini, rearranging his Rhyparochromini into four tribes, Myodochini, Rhyparochromini, Beosini, and Gonianotini, of which only the first tribe is still substantially the same as in Scudder's concept.

In fact all of these classifications agree on placing in the one section a group of genera which have the pronotum constricted near the middle (and hence divided into two lobes) and in which the lateral margins of the pronotum are not explanate or acute but obtuse or rounded. Stål and Distant called it the division Myodocharia, Scudder the subtribe Plociomerina, Slater and Sweet the Myodochini, but all agree in placing in it genera of the general appearance of *Erlacda* Signoret, *Eucosmetus* Bergroth, *Myodocha* Latreille, *Pachybrachius* Hahn, *Paromius* Fieber and *Ptochiomera* Say. Scudder's classification differs in one point. Whereas his Plociomerina (without exception so far as I can judge from published figures) contains genera of the general appearance of those just listed, not all genera of this appearance belong to the "Plociomerina"; *e.g.*, *Bedunia* Stål (= *Austropamera* Distant) belongs to the Stygnocorini.

It came as a considerable surprise to both Scudder and myself when working on our joint revision of *Dieuches* Dohrn to find the anomalous *Dieuches rafaeli* Evans belonged to the Myodochini. Subsequently I found *D. rafaeli* to be a synonym of *Euander lacertosus* (Erichson) and that related to *Euander* in our collections were a series of other genera including *Udeocoris* Bergroth, the Australian species of "*Lamprodema*", and several new genera, all belonging likewise to the Myodochini. Scudder working independently discovered that "*Lamprodema*" *coleopteroides* belongs to the Myodochini, but that *L. maura* belongs to the Rhyparochromini (*in litt.*).

These make up a group of genera and species related to *Euander*, and in general do not resemble closely the other Myodochines. An incipient transverse constriction of the pronotum is present in several of the genera (*Euander* Stål and *Porander* gen. nov.) but in two other genera (*Udeocoris* Bergroth, and *Telocoris* gen. nov.) this is quite absent. All the species tend to be flattened and shiny and brachypterous forms are common, along with normal, macropterous ones in the same species. Several of the species are known only from brachypterous forms.

Frequent development of brachyptery tends to link this group with a group of genera which, although the pronotum is distinctly divided into two lobes, are brachypterous. This second group includes *Fontejus* Stål (= *Albanyaria* Distant) and two new genera *Cryptocoris* gen. nov. and *Zygocoris* gen. nov., all from Australia, and from other regions *Aegyptocoris* China, *Carpilus* Stål, *Cnemodus* H. and S., *Erlacda* Signoret (sometimes), *Ptochiomera* Say (sometimes), *Prytanes* Distant and *Sisamnes* Distant, amongst others.

It is hard to avoid the conclusion that the first group makes up a section of the brachypterous Mydochini diverging from the general facies of the tribe. It is possibly a late development in the group towards specialized small shining forms, and linked through *Euander*, *Porander* and the *Fontejus*, *Ptochiomera* group of genera with the more typical fast-moving Myodochines of the litter and soil surface. *Euander* and *Porander* definitely live on low shrubs in the forests of higher rainfall areas, *Udeocoris* is a soil surface inhabitant of either wet or arid areas, but the exact habitat of the others, whether heath-like plants or the deep litter layers, remains undetermined.

Although genera like *Udeocoris* and *Telocoris* are very distinct in appearance from the other Myodochini they are very close in structure to forms like *Euander* and *Porander*, where the transverse construction between the two lobes of the pronotum is fully developed. These in turn grade into forms like *Cryptocoris, Zygocoris* and *Fontejus* where the pronotal constriction is very well marked. This has necessitated this paper including all the Australian genera of Myodochini in which brachyptery occurs.

The genera and species of the brachypterous section of Australian Myodochini may be distinguished by the following key:—

1. Pronotum with an incipient transverse constriction near or well behind the middle 2
   Pronotum without any trace of a transverse constriction, although the hind portion may be paler than the anterior 11
2. Pronotum with transverse constriction just behind middle 3
   Pronotum with transverse constriction well behind middle 5
3. Hemelytra always macropterous, hind margin of pronotum concave in front of scutellum . . . . *Euander lacertosus* (Erichs.)
   Hemelytra macropterous or with very reduced membrane, hind margin of pronotum shallowly curved over whole length 4
4. Hind lobe of pronotum mostly pale, likewise hemelytra, at least in brachterous form . . . . *Euander torquatus* (Erichs.)
   Hind lobe of pronotum dark with two prominent pale lateral patches, hemelytra mostly dark . . . . *Euander cicero* sp. nov.
5. Pronotum and head for the most part smooth and shining 6
   Pronotum, head and scutellum coarsely and densely punctate . . . . *Porander scudderi* gen. nov. & sp. nov.

6. Pronotum not markedly longer than wide, fore femora incrassate or not	7
Pronotum conspicuously longer than wide, fore femora incrassate	8
7. Fore femora not incrassate, corium dark with a pale oblique marginal fascia	*Cryptocoris fasciata* gen. nov. & sp. nov.
Fore femora incrassate and finely spined beneath, corium ochraceous with three lateral black spots	*Fontejus multicoloratus* (Dist.)
8. Hemelytra not surpassing middle of abdomen	*Zygocoris tindalei* gen. nov. & sp. nov.
Hemelytra surpassing middle of abdomen	9
9. Hemelytra dark, at least apically, with conspicuous oblique pale marginal fascia near apex	*Fontejus sidnicus* (Stål)
Hemelytra ochraceous or ochraceous-piceous, nearer black	10
10. Hemelytra evenly coloured pale ochraceous, or ochraceous-piceous, with only the vaguest suggestion of two pale lateral lighter areas	*Fontejus collaris* (Walker)
Hemelytra castaneous with several areas of yellowish-ochraceous on the disc, and two luteous patches on margin near apex. Scutellum with a paler patch near each basal angle	*Fontejus westraliensis* sp. nov.
11. Hind portion of pronotum lighter in colour than anterior region	12
Hind portion of pronotum for the most part concolorous with anterior region, and possibly humeral angles pale	13

12. Hemelytra with small scattered fuscous patches . . . . *Udeocoris rolandi* (Dist.) comb. nov.

Hemelytra with a large curved band of fuscous in the posterior region of corium running from behind middle of outer margin to claval suture running along claval suture to hind margin of corium and along hind margin to outer margin . . . . *Udeocoris scudderi* sp. nov.

13. Corium and clavus mainly dark . . . . *Udeocoris nigroaeneus* (Erichs.)

Corium and clavus mainly pale . . . . *Telocoris vittata* (Dist.) gen. nov. & comb. nov.

Fontejus Stål 1862

Fontejus Stål, 1862, Stettin. ent. Ztg., 23: 314. 1865, Hemiptera Africana 2: 153. 1874, K. svenska Vetensk Akad. Handl., 12 (1): 145 & 154.

Albanyaria Distant, 1918, Ann. Mag. nat. Hist., (9) 2: 258, *new synonymy.*

Head triangular, somewhat longer than wide, eyes not touching anterior margin of pronotum. Antennae moderately long, first segment surpassing apex of head. Pronotum elongate, constricted near base. Anterior margin almost straight, hind margin feebly convex. Lateral margin feebly convex in front of constriction. No obvious collar to pronotum.

Scutellum a little longer than wide. Hemelytra abbreviated, not reaching apex of abdomen, membrane very reduced and dividing line between clavus and corium obscure.

Fore femora very incrassate with a number of teeth in the apical halves. Fore tibiae feebly curved with in the male a prominent spine beyond the middle.

Head, pronotum, hemelytra and fore femora with long sparse hairs in addition to the normal fine pilosity shown throughout this group of genera.

Type of genus: *Fontejus sidnicus* (Stål)

This genus is the most closely related of this whole group of Australian brachypterous genera of Myodochini to the normal *Pachybrachius* and *Eucosmetus* type. The constriction in the pronotum is placed well posteriorad (except in *F. multicoloratus*); the whole facies is typically Myodochine and is not greatly different from that of extra-Australian brachypterous Myodochine genera.

Fontejus sidnicus (Stål)

Plate 14, fig. B

Rhyparochromus sidnicus Stål, 1859: K. svenska Fregatten Eugenies Resa etc. 11 (1): 246.

Black or dark chocolate brown with brown and yellowish-white markings. Head with eyes black or dark chocolate brown. First three segments of antennae dark brown, second and third infuscated at apex. Fourth black with a broad luteous band near base.

Pronotum concolorous with head, except for two pale luteous points, one on either side just behind constriction. One specimen has two additional luteous patches along the hind margin. Hind margin shallowly excavate, exterior margin with distinct wide collar, lateral margins convex to constriction, behind that convex again.

Scutellum always black with extreme apex luteous. Sparsely punctate.

Corium and clavus difficult to distinguish and chocolate brown, either becoming black apically, or all black. On the lateral margin three luteous patches, one at the extreme apex and the second at about level of tip of scutellum small, the third on the margin at the three-quarter spot, large, oblique, reaching almost to mid-line of each hardened "elytron". Without membrane, and hemelytra reaching back to about two-thirds length of abdomen.

Abdomen above always black, with two pale luteous patches, one alongside the large luteous patch on hemelytra, the other just behind apex of hemelytra.

Body beneath black or chocolate brown. Rostrum dark brown. Pale spots above insertion of coxae and on lateral margins of abdomen contiguous with those above.

Fore femora black, armed beneath with a single row of six stout spines. Legs otherwise dark brown, femora paler basally.

Head, pronotum, hemelytra and fore femora covered with sparse long hairs.

Length: 6 mm.

Locality: South Australia: Stickney Island, N. B. Tindale; Meningie, 12 September 1959, H. V. Mincham; Ardrossan, February 1879, collector not indicated; attracted to light, Ravine des Casoars, Kangaroo Island, 18 October 1951, G. F. Gross (S.A.M.). New South Wales: North Sydney, Taronga Park, 14 October 1913, A. Musgrave (A.M.).

Fontejus collaris (Walker)

Plate 14, fig. D

Rhyparochromus collaris Walker, 1872, Cat. Heter., 5: 111. Distant, 1901, Ann. Mag. nat. Hist. (4) 8: 510.

Fontejus collaris Stål, 1874, K. svenska Vetensk. Akad. Handl., 12 (1): 154.

Walker and Stål's descriptions appear to apply to the same insect although in Stål's account no reference is made to Walker's description. Distant says Walker's type is lost.

Black and chocolate brown. Head, anterior lobe of pronotum, scutellum, fourth segment of antennae (except for pale luteous subbasal ring) and sometimes apices of first, second and third segments and femora black.

Antennae, hind lobe of pronotum, hemelytra, upperside of abdomen (except for a broad median longitudinal yellowish or pale brown strips), tarsi and tibiae (latter apically infuscated) brown to chocolate brown. Some small pale patches on hemelytra and hind lobe of pronotum, tip of scutellum pale.

Beneath head and thorax black, except just above insertion of coxae, which is luteous. Rostrum and abdomen chocolate brown, abdomen beneath and above with a fine reddish pilosity. Head, pronotum and hemelytra with a sparse long pilosity.

Length: 6-8 mm.

Locality: Tasmania: one male in tussocks, New Norfolk, A. M. Lea; one male, Hobart, 6-16 November 1928, C. Cole; one female No. 2218, Scamander (S.A.M.); Eaglehawk Neck, 12 February-3 March 1913, R. E. Turner (B.M.). South Australia: Cooper Creek, W. E. Hodson (B.M.).

Walker records the species from Tasmania and South Australia (Adelaide), Stål from New South Wales (Sydney).

Fontejus westraliensis sp. nov.

Plate 14, fig. C

Very similar in general appearance to *F. collaris* Walker. Chocolate brown. Eyes and first and fourth segments of antennae black, the latter with a pale luteous subbasal ring.

Pronotum with a dark median longitudinal stripe and sometimes the very lateral margin infuscated. Scutellum mostly black, but with reddish-chocolate basal angles and a luteus tip.

Hemelytra chocolate, with a pattern of paler and darker patches, two feebly marked pale lateral fasciae near apex of hemelytra.

Upperside of abdomen reddish-chocolate and black variegate.

Underside of head, pronotum and abdomen black. Luteous immediately above fore and hind coxae, reddish-chocolate patches on the hind margin of the abdominal segments, lateral margin of abdomen also reddish-chocolate variegate. Middle and hind femora and all tibiae and tarsi apically infuscated.

Underside of abdomen with a fine golden silky pilosity, pronotum and on hemelytra with long sparse hairs.

Length: 7 mm.

Locality: Western Australia: Holotype male and allotype female, Katanning, 2 May 1938, K. R. Norris (C.S.I.R.O.).

This species is easily distinguished from *F. collaris* by the variegated hemelytra, which contain several areas of black, by the brown head, and the wholly brown pronotum, which has a darker longitudinal median streak.

Fontejus multicoloratus (Distant) nov. comb.

Albanyaria multicolorata Distant, 1918: Ann. Mag. nat. Hist., (9) 2: 258.

"Head, anterior lobe of pronotum, and the scutellum black; the narrow posterior pronotal lobe and the extreme apex of scutellum greyish white; antennae ochraceous, apex of third joint and more than apical half of fourth black; corium ochraceous, the lateral marginal areas with the three prominent black spots, the smaller near base, the largest near middle, and the third at apex, the exposed apical area of the abdomen black; body beneath black; posterior sternal segmental margins very pale ochraceous; legs reddish ochraceous, apical halves of the anterior femora and apices of the tibiae and tarsi black;

antennae with the second joint slightly longer than the third and about subequal with the fourth; scutellum more or less rugosely punctate; clavus linearly somewhat coarsely punctate; rostrum ochraceous, the basal joint black, remaining joints imperfectly seen in carded type.'' (Distant's original description.)

Length: 5½ mm.

Locality: Western Australia: Albany (J. J. Walker) Distant's type (B.M.) King George Sound, no collector (G. G. E. Scudder, Vancouver).

I have not seen this species. *Fontejus multicoloratus* along with *Cryptocoris fasciata* seems to mark the next step forward in the divergence of certain Australian Myodochines from the characteristic facies of the group. In these two genera the pronotum is considerably shortened and is barely longer than wide and this is also typical of all the following forms treated in this paper.

Genus **Zygocoris** gen. nov.

Head elongate, rather acuminate, eyes not very prominent and placed well in front of pronotal margin. Pronotum hardly wider than head with eyes, with an incipient transverse sulcus placed only a short way in front of the hind margin. Anterior margin of pronotum concave, posterior margin almost straight, lateral margins almost straight from forward of sulcus curving in just before apex and also in region of sulcus. Margins of posterior lobe somewhat divergent from sulcus backwards. Collar flattened, not very distinct.

Scutellum small, about as long as wide. Hemelytra very coriaceous and ''elytra like'', corium and clavus not separable and no trace of membrane, abbreviated, not reaching behind middle of abdomen.

Fore femora very expanded, only twice as long as wide, not quite circular in cross section but feebly flattened laterally with three moderate teeth and a number of only slightly smaller ones on the underside in the apical half. Fore tibiae shorter than femora, strongly curved, apices expanded, with two rows of denticles on their under surfaces. Hind tarsi with the first segment not longer than apical pair together.

Type of genus: *Zygocoris tindalei* sp. nov.

This genus has affinities with the previous one, *Fontejus,* but differs from it in its longer head and pronotum and massive front femora. It also appears to be quite close to *Fontejanus* Breddin from India. Like *Fontejanus* it has massive front femora, curved and armed front tibiae, a sulcus on the pronotum placed just in front of the hind margin and very abbreviated hemelytra. It differs from *Fontejanus* in not having the eyes touching the anterior margin of the pronotum; it does not appear to have ocelli; the mid femora are unarmed and the first segment of the third tarsi is shorter than the apical pair together. *Fontejanus* must be considered a member of this new group of Myodochini by virtue of the brachypterous condition of the hemelytra, although the transverse sulcus of the pronotum is strong and gives it a more typical Myodochine pronotum than others of these Australian genera. The link between typical Myodochini appears to be either through *Zygocoris* and *Fontejanus* or through *Euander*.

Zygocoris tindalei sp. nov.

Plate 15, fig. E

Chocolate brown with hind lobe of pronotum and ground colour of "elytra" luteous white. "Elytra" with a T-shaped fuscous patch with the head of the T laying along the inner margin, and the stem of the T reaching the outer margin at about the middle. Middle and hind femora, all tibiae and tarsi, extreme apices of fore femora, second segment of antennae (except at apex), and base of third segment, yellowish or yellowish brown.

Head smooth and shining, with sparse long hairs. Anterior lobe of pronotum sparsely punctate, otherwise smooth and shining and also with sparse long hairs. Hind lobe of pronotum and "elytra" sparsely punctate, the punctations are brown in the pale areas.

Scutellum black, with pale tip, feebly transversely impressed in front of middle. Hemelytra very abbreviated into coriaceous "elytra", apical margin truncate, feebly sinuate, outer apical angles rounded.

Body beneath shining brown, with a short sparse white pilosity.

Length: 4-5 mm.

Locality: South Australia: Holotype male, allotype female and three paratype females, Mount Lofty Ranges, N. B. Tindale (S.A.M.). Paratype male and two paratype females, ex soil Gile's Corner, July 1950 (W.A.R.I.). Australia: Four paratypes, with *Camponotus* or *Iridomyrmex* (Formicidae) (S.A.M.).

Genus **Cryptocoris** gen. nov.

Head about as long as wide, feebly convex, eyes not very prominent, almost touching anterior margin of pronotum. No ocelli. Pronotum as wide as or slightly narrower than head with eyes, widest at anterior and posterior margins. Anterior margin of pronotum straight, posterior margin feebly concave. Lateral margins straight and converging as they run back towards constriction which is placed well posteriad, thence diverging again to hind margin. No collar.

Scutellum fairly small, almost equilateral. Hemelytra coriaceous and elytra-like, corium and clavus not separable and strongly but sparsely punctate: a very reduced membrane present. Hemelytra reach a little behind middle of abdomen.

Fore femora somewhat enlarged, with some terminal teeth beneath. Fore tibiae feebly curved. First segment of hind tarsi longer than remaining two together.

Type of genus: *Cryptocoris fasciata* sp. nov.

This genus appears to have some affinities with *Zygocoris.* The fore femora are neither so markedly expanded nor so conspicuously armed. In common with several other genera in this section it has abbreviated hemelytra, but the pronotum is not so elongate and in this feature it appears to be allied to the next genus.

Cryptocoris fasciata sp. nov.

Plate 15, fig. C

Shining black. Hind lobe of pronotum and a spot on the lateral margin of hemelytra luteous. Membrane milky white. Basal exterior margin of hemelytra, tibiae, tarsi and second segment of antennae pale brown infuscated at apex. Eyes, third and fourth segments of antennae and basal two-thirds of first segment dark brown. Beneath black, hind margin of prothorax and metathorax broadly, and a spot on the mesothorax above insertion of coxae, luteous.

Head smooth and shining, with several long sparse hairs. Anterior lobe of pronotum likewise smooth and shining, with a few shorter pale hairs. Hind lobe with a few pale brown punctations near transverse constriction. Scutellum and coriaceous portion of hemelytra also smooth and shining. Scutellum and hemelytra with a moderate number of course punctations arranged in rows. Hind margin of abbreviated and fused corium and clavus straight. Oblique lateral margins broadly convex. Hemelytra with short and sparse pilosity.

Beneath with a fine short pilosity.

Length: 3-4 mm.

Locality: South Australia: Holotype, Lucindale, Feuerheerdt (S.A.M.). A.C.T.: Allotype and one paratype, Blundell's[1], under stones, 16 September 1930, W. K. Hughes (C.S.I.R.O.).

Genus **Euander** Stål.

Euander Stål, 1865, Hemiptera Africana 2: 154. 1874, K. svenska Vetensk Akad. Handl., 12 (1): 156.

Pronotum at apex as wide as head with eyes, as long as wide or a little longer, lateral margins obtuse, narrowed towards apex, behind middle slightly sinuate. Anterior margin of pronotum slightly elevated and forming a feeble collar, pronotum with an obsolete transverse sulcus behind middle, hind lobe paler than fore lobe.

Scutellum distinctly longer than wide. Corium and clavus with distinct rows of punctations with scattered punctations between them.

Fore femora moderately incrassated, beneath with three largish teeth and many smaller ones, fore tibiae of male curved and with a large tooth towards apex. First segment of hind tarsi as long as apical pair together.

Type of genus: *E. lacertosus* (Erichson)

Euander marks the next step forward in the development of the peculiar endemic group of Australian genera, the transverse constriction of the short pronotum has moved anteriad to the middle, changing the whole facies of the insect.

Euander lacertosus (Erichson)

Plate 16, fig. A

Pachymerus lacertosus Erichson, 1842: Archiv für Naturges., 8 (1): 279. Woodward, 1962: J. ent. Soc. Qld., 1: 50, figs.

Rhyparochromus lacertosus Dohrn, 1859, Catalogus Hemipterorum: 34.

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[1] This locality, which appears in several other places in this paper, was a farm 18 miles west of Canberra at the eastern foot of Mount Coree, since resumed for water conservation purposes, and now largely planted in pine forest.

Euander lacertosus Stål, 1867, Berlin ent. Ztg., 10: 161. 1874: K. svenska Vetensk Akad. Handl., 12 (1): 158.

Rhyparochromus pictipennis Dallas, 1852: List. Hem. Ins., 2: 571. (new synonomy)

Dieuches pictipennis Distant, 1901: Ann. Mag. nat. Hist., (7) 8: 504.

Dieuches rafaeli Evans, 1939: Bull. ent. Res., 30: 305. (new synonomy)

The species is also mentioned and figured but not named by Lea, 1908, Insect & Fungus Pests of Orchard and Farm (Hobart 3rd Ed., 73-74.

Black, with brown and yellowish white markings. Head and eyes mainly black, head has patches of heavy pubescence. First segment of antennae black with a few small strong spines, second segment mostly brown, apex black, third segment with basal third brown, distal two-thirds black, last segment black with a pale band near base.

Anterior lobe of pronotum black with hoary punctations near edge, collar brownish with three conspicuous yellowish points. Hind lobe luteous with black punctations. Hind margin of pronotum excavate in front of scutellum, lateral margins with a whitish- or yellowish-spot in the position of the sulcus.

Scutellum black, with extreme apex white and usually two orange points near the apex on the disc. A few scattered punctations on the disc.

Corium and clavus in the main yellowish—testaceous with several rows of dark punctations, mostly following the curve of the veins, and many other scattered punctations. There are several small fuscous spots and a large black spot on the disc of the corium two-thirds of the way back. Also the extreme apex is black. Reflexed margin luteous. Membrane blackish or brownish with veins pale, together with many pale points. Hemelytra always fully developed.

Body beneath black, with a very fine adpressed silky pilosity, episterna and epimera of each thoracic segment pale. Trochanters, bases of second and third femora, tibiae except at apices and tarsi brownish. Fore tibiae always curved expanded at apex, and in the males with a prominent tooth at base of expansion.

Length: 5-7 mm.

Foodplants: Common in dry sclerophyll forest in South Australia; a pest of strawberries in Tasmania.

Our figure checked by Dr. T. E. Woodward in Europe, against Erichson's type.

Locality: Queensland: Cedar Creek, Mjöberg; Mount Tambourine, Mjöberg; Herberton, Mjöberg (R.M.S.). New South Wales: Three, Bombala, January 1930, Rev. A. J. Barrett (Reg. Nos. K 61432 and K 61180); Mount Irvine, 31 January 1944, B. A. Messmer; Nepean River, Glenbrook Creek, 25 February 1923, A. Musgrave; Sawpit Creek, Mount Kosciusko, 8 January 1929, A. Musgrave (A.M.) Dorrigo (S.A.M.); two, Nullo Mountain, 20 m. N.E. of Rylstone, 20 November 1950, T. G. Campbell; two, Island Bend, Snowy Mountains, 20 October 1951, D. J. Wimbush (C.S.I.R.O.). Australian Capital Territory: Six, attacking strawberries, 4 December 1940, A. J. Nicholson; three, Blundell's, 7 January 1930, J. Evans; Canberra, May 1929, J. Evans; Canberra, February, G. F. Hill; Cotter River, 24 (month not distinct), 1929, M. Fuller; Jervis Bay, 18 September 1951, T. G. Campbell (C.S.I.R.O.). Victoria: Toora, 16 December 1937, R. V. Fyfe (C.S.I.R.O.); near Melbourne, G. F. Hill; Kewell (S.A.M.); Mallee District 1913, donated 5 October 1922 by F. P. Spry (N.M.); Ferntree Gully, 16 October 1927, F. E. Wilson (A.M.). Tasmania: Three, Launceston (No. 2218); Launceston 12 February 1914; Launceston, 1 March 1914; Launceston; Launceston, 1 April 1916, F. M. Littler; five Hobart (Nos. 7-6-16/1, 3-6-17/21, 23, 24 and 25—possible these are dates), C. E. Cole; in fallen leaves, Hobart, Lea (S.A.M.) Lake St. Claire, 13 January 1937, G. and C. Davis; Rinadeena Siding, Mount Lyell Line, 11 January 1937, G. and C. Davis; Lake Margaret, 12 January 1937, H. and C. Davis (A.M.); Moogara, January 1938, T. Raphael (coll. G. G. E. Scudder, Vancouver). South Australia: Thirty-seven, by sweeping undergrowth, *Eucalyptus obliqua* dry sclerophyll forest, Naracoorte Cave Reserve, 25 October 1958, G. F. Gross; on *Poa caespitosa* scrub, Hundred of Joanna, 28 October 1958, N. B. Tindale; three, Clare, 19 April 1884, J. G. O. Tepper; two, Vivonne Bay, Kangaroo Island, Museum Expedition, February 1926; St. Marys (S.A.M.); in large numbers on Cape Weed, *Cryptostemma calendulaceum*, Inman Valley, 25 January 1955, P. M. Grosvenor; attacking strawberries; Ashton, November 1945, Mr. Hook (W.A.R.I.). Western Australia: King George Sound (B.M.); Collie, 13 January 1957, A. Snell (N.M.).

Euander cicero sp. nov.

Plate 14, fig. A

Black with brown and yellowish-white markings. Head black, with patches of hoary pubescence, more elongate than in *E. lacertosus*. First segment of antennae black, second black at apex and third black in terminal half, otherwise brown, fourth segment black with a luteous band near base.

Anterior lobe of pronotum velvety black with three pale points on anterior margin. Hind lobe likewise velvety black except for two large luteous areas along each lateral margin and two obsolete brown longitudinal bars, one on each side of mid line.

Scutellum completely velvety black. Corium and clavus velvety black with most of the basal half of corium and outer half of clavus contiguous to it luteous, also a large oblong luteous area on each lateral margin near apex. Some brownish marks on apical exterior angle of clavus and apical interior area of corium. Membrane dark grey with some lighter points, very reduced. Distinction between corium and clavus clear.

Body beneath black, abdomen and underside of head with a hoary white pubescence. Propleurae and mesopleurae strongly punctate and with a trace of a pale lemon yellow around each punctation. Metapleurae basally strongly rugulose. A spot above insertion of coxae on propleurae and metapleurae to dorsum luteous.

Second segment of rostrum, basal third of all femora, tarsi (except apically), and tibiae brown. Apices of fore tibiae expanded.

Length: 4·5 mm.

Locality: New South Wales: Holotype female and one paratype (head and thorax only), Hotel Kosciusko, Snowy Mountains, October 1957, D. J. Wimbush (C.S.I.R.O.); three paratype females, Mount Kosciusko, January 1957, H. J. Carter (A.M.). Australian Capital Territory: One paratype female, Mount Gingera, 5 December 1950, H. Cane (C.S.I.R.O.).

Euander torquatus (Erichson) nov. comb.

Plate 16, fig. C

Pachymerus torquatus Erichson, 1842: Archiv für Naturges. 8 (1): 280. Woodward, 1962: J. ent. Soc. Qld., 1: 52, figures.

Rhyparochromus torquatus Dohrn, 1859: Catalogus Hemipterorum: 34.

Black with brown and yellow markings. Head black, with traces of a heavy pubescence, more elongate than *E. lacertosus*. First segment of antennae black, brownish at apex, second segment and extreme base of third segment pale brown, third segment otherwise and fourth black.

Anterior lobe of pronotum black with a faint tinge of brown, collar a shade paler. Hind lobe pale yellow, with a few brownish punctations and a few blackish spots one of which is largish and runs along the midline into the black of the fore lobe. Hind margin broadly excavate, lateral margins fairly straight, narrowing towards head.

Scutellum black with extreme apex white and two orange points near the apex on the disc. Sometimes these run into the white tip.

Corium and clavus yellowish-white with numerous blackish-brown punctations which coalesce to form a longitudinal black streak on the clavus and a vaguely triangular black patch in the basal third of the corium. The corium also has a large blackish patch just behind middle connected by one or two black bars to the black apical area of the corium. In the macropterous specimen the black on the corium is very much more extensive. Membrane complete or very reduced, if the latter then distinction between clavus and corium not obvious and hemelytra apparently hardened and rather "elytra" like.

Body beneath black, episterna and epimera of each thoracic segment pale. Trochanters pale, bases of second and third femora, tibiae, except at apices, and tarsi brownish. Apices of tibiae not expanded.

Length: 4-5.2 mm.

Locality: Australian Capital Territory: One macropterous specimen, Canberra, November 1929, J. Evans. Victoria: In moss, Ferntree Gully, 1 November 1918, F. E. Wilson; two in tussocks, Ringwood, F. E. Wilson (S.A.M.); Millgrove, 13 April 1927, F. E. Wilson (A.M.); Ferntree Gully, 27 July 1919, F. P. Spry; six same locality and collector, without date; two same locality and collector, 7 October 1920; fourteen, same locality, 17 and 24 July 1920, 26 July 1924 and 26 April 1925, F. E. Wilson; Eltham, September 1927, F. E. Wilson; six, Upway, J. E. Dixon; five without exact date or locality, J. E. Dixon; five also without exact locality or date, F. P. Spry (N.M.).

Our figure was checked, in Europe, by Dr. T. E. Woodward, against Erichson's type, from Tasmania.

Genus **Porander** gen. nov.

Pronotum at apex narrower than head with eyes, wider at base than length, disc somewhat flattened with an incipient transverse sulcus well behind middle. Anterior margin raised to form a conspicuous collar which has two short lateral tooth-like processes. Lateral margins curved in just before collar, sinuate in region of sulcus, obtuse in front of sulcus, with an acute margin behind.

Scutellum about as long as wide, hemelytra with abbreviated membrane and dividing line between corium and clavus obscure. Punctations on hemelytra numerous but not so obviously placed in lines as on *Euander*.

Head, anterior lobe of pronotum and scutellum with numerous large pit-like punctations, each containing a short white hair.

Fore-femora much more incrassated than *Euander* with four prominent teeth beneath and many smaller ones. Fore-tibiae curved. First segment of tarsi longer than remaining two together.

Type of genus: *Porander scudderi* sp. nov.

This genus is apparently closely related to *Euander*. It differs from it in the curious punctations of the head, fore lobe of pronotum, and scutellum, and the much more incrassate fore femora. The pronotal constriction is well posteriad and *Porander*, although related to Euander, appears to be also on a side branch from the main line of development.

Porander scudderi sp. nov.

Plate 15, fig. D

Black with luteous white markings. Head black, eyes dark brown. Head has a rather short white sparse pubescence mainly located in the punctations. First, third and fourth segments of antennae black, second segment brown.

Anterior lobe of pronotum black with numerous coarse deep punctations each bearing a hair and with odd small smooth areas scattered over disc. Collar narrow, brownish-luteous with a single row of punctations across it. Hind lobe of pronotum luteous with numerous coarse brownish punctations many of them concentrated into about five longitudinal fuscous areas.

Scutellum black, with same hair bearing pit-like punctations as head, extreme apex white and also two white points on disc near apex, sometimes confluent with it.

Hemelytra with a vestigial membrane, luteous with numerous blackish-brown punctations and some odd small infuscated patches.

Body beneath black, rostrum brownish. A luteous spot on the propleurae on the frontal margin beneath and marking the end of sulcus above. Visible portion of connexivum (except for a transverse dark bar), hind margin of metapleura (except for a cluster of dark punctations), and patches on upper hind corners of abdominal pleurae V, VI, and VII, luteous. All tibiae and tarsi brownish, extreme apices of femora and bases of tibiae luteous.

Length: 4·6 mm.

Locality: South Australia: Holotype male, allotype female, two paratype males, sweeping undergrowth, *Eucalyptus obliqua* dry sclerophyll forest, Naracoorte Cave Reserve, 25 October 1958, G. F. Gross; two paratype males, one nymph, Vivonne Bay, Kangaroo Island, Museum Expedition, February 1926 (S.A.M.). New South Wales: One paratype male, Gosford (S.A.M.); Sydney, 2 November 1930, K. Spence; Waverley, Sydney, 1 November 1901, W.G.B.; North Bondi, October 1930, K.K.S. (A.M.). Australian Capital Territory: Three paratype males and one paratype female, sweeping vegetation, Black Mountain, Canberra, 26 November 1959, G. F. Gross (S.A.M.). Victoria: One paratype female, Woori Yallock, F. E. Wilson; two paratype females, Eltham, J. E. Dixon (N.M.). Tasmania: One paratype, Bridport, October 1913 (S.A.M.); in fallen leaves, Hobart, Lea (G. G. E. Scudder Coll., Vancouver).

Genus **Udeocoris** Bergroth

Udeocoris Bergroth, 1918: Ann. hist. nat. Mus. hung., 16: 310.

Head oblong, with eyes a little wider than apex of pronotum. Eyes touching or not anterior margin of pronotum, ocelli present, close to eyes. Pronotum wider than long, without a collar or any trace of a sulcus; anterior margin straight, lateral margins straight, converging towards apex, fairly acute or almost carinate. Humeral angles of pronotum rounded, hind margin shallowly concave. Disc of pronotum nearly flat, a little more arched in the anterior region.

Scutellum about as long as wide or longer; very flat, sometimes finely punctate, just a trace of longitudinal keel. Hemelytra with or without an abbreviated membrane, when membrane is abbreviated the hemelytra become coriaceous and the division between corium and clavus obscure.

Fore femora moderately incrassated, with a row of four to seven robust spines on the apical half on the inner ventral margin, the teeth becoming regularly smaller from apex of femora to middle. Hind and middle femora flattened, first segment of last tarsus longer than the apical pair together.

Type of genus: *Udeocoris nigroaeneus* (Erichson)

The genus is evidently close to *Euander* which it resembles in general coloration, in the black fore portion of the pronotum and stramineous but darkly punctate hind region. It differs in showing not the slightest trace of a transverse constriction on the pronotum. It therefore seems to be the first member of a sub-line of genera of these peculiar Myodochini in which the typical Myodochine constriction is completely lost. *Udeocoris* is the apparent link between *Euander* and *Telocoris*.

Udeocoris nigroaeneus (Erichs)

Plate 15, fig. B

Pachymerus nigroaeneus Erichson, 1842: Arch. für Naturges., 8 (1): 280. Woodward, 1962: J. ent. Soc. Qld., 1: 54, figures.

Rhyparochromus nigroaeneus Dohrn, 1859: Catalogus Hemipterorum: 34.

Udeocoris nigroaeneus Bergroth, 1918: Ann. hist. nat. Mus. hung., 16: 311.

Shining black, with or without yellowish-brown markings. Head shining black with scattered long hairs, eyes dark brown. First and last segments of antennae dark chocolate brown, second and third segments brown. Last three segments with scattered long hairs and a fine adpressed pilosity.

Pronotum shining black, very sparsely punctate. Sometimes the humeral angles are obscurely brownish.

Scutellum black, sparsely punctate, extreme tip usually pale. Hemelytra occasionally developed but generally with very reduced membrane and distinction between clavus and corium obscure. When humeral angles of the pronotum are pale the costal margin is also narrowly brown along the basal half. In one macropterous specimen there is also a pale spot on the costal margin just before the apex. Membrane when developed hyaline, brownish near apical margin of corium. In the fully winged form the punctures on the clavus are not in three regular rows.

Beneath shining black, connexivium, bottom edges of epimera and episterna, trochanters, apices of femora, tibiae and tarsi yellowish-brown. Tibiae with scattered black spines. Rostrum dark brown. The Rockhampton specimen is castaneous.

Length: 4.5-6 mm.

Locality: Torres Straits: Three, Moa Island, C. T. McNamara (S.A.M.). Queensland: Cairns; Townsville (S.A.M.) Scrubby Creek, 1 mile E. of Fairy Bower, Rockhampton, 3 August 1950, T. G. Campbell (C.S.I.R.O.). This last specimen is wholly castaneous, with pale eyes, antennae, tibiae and tarsi. New South Wales: Two, Island Bend, Snowy Mountains, 20 October 1957, D. J. Wimbush; Hotel Kosciusko, Snowy Mountains, 10 October 1957, D. J. Wimbush (C.S.I.R.O.); Mount Kosciusko, 5,000ft., February 1926, H. J. Carter (A.M.). Australian Capital Territory: Blundell's, 10 October 1930, W. K. Hughs (C.S.I.R.O.). Victoria: Bogong Plains, 5,600-6,000ft., January 1928, F. E. Wilson; Mildura (N.M.). Tasmania; In tussocks, Stanley; Lake Margaret, 12 January 1937, G. and C. Davis—this specimen is fully winged; Magnet, G. P. Whitley; Cradle Mountain, Carter and Lea; same locality, 27 December 1915, Prof. Flynn; twelve, Great Lake, December 1906 and 1907, J. W. Mellor; in tussocks, Huon River, Lea; Waratah, 12 March 1916 (S.A.M.). South Australia: Berlese Funnel out of leaf debris, Naracoorte Bog, February 1959, P. Aitken (S.A.M.). Western Australia: Boyup Brook, March 1936, D. Q. Norris; Fremantle, 15 November 1934, K. R. Norris (C.S.I.R.O.); Warren River, W. D. Dodd; Swan River; two without exact locality (S.A.M.). Timor: There is a species hardly distinguishable from this in Timor, but all specimens I have are macropterous, whereas macroptery is very rare in the Australian specimens. A larger series is needed from the island before its identity can be established, these I hope to obtain from a coming second expedition to the island.

Our figure was checked by Dr. T. E. Woodward against Erichson's type and specimens labelled "*Udeocoris* (n.g.) *nigroaeneus*" in Bergroth's handwriting, in the collection of the British Museum, from Fremantle, Western Australia.

Udeocoris rolandi (Distant)

Plate 16, fig. B

Naudarensia rolandi Distant, 1918: Ann. Mag. nat. Hist., (9) 2: 492.

Black, with luteous and brown markings. Head black with sparse black hairs, finely rugulose, eyes brown. First segment of antennae (except at apex, which is paler) and fourth segment dark brown, second and third segments yellowish-brown. First, second and third segments with long hairs.

Anterior two-thirds of pronotum shining black, densely punctate, but extreme anterior margin yellowish-brown. Hind portion of pronotum luteous but with numerous black or brown punctations tending to darken the whole area, five vague fuscous longitudinal bands further darken the area.

Scutellum black, feebly arched with punctations arranged in two longitudinal rows, apex white sometimes with odd white points on the disc in the apical region.

Hemelytra may be normal, or brachypterous with membrane very reduced. Ground colour of corium and clavus luteous but with many brown or black punctations making the whole appear darker, there are seven fuscous areas, the largest being on the apical margin of the corium and the other in the apical angle. When the membrane is reduced the "elytra" leave uncovered the last two, and half of the third-to-last abdominal segments. Membrane black with white veins.

Beneath black with some long white hairs and an extremely fine white adpressed pilosity. Rostrum, rostral canal, the anterior ventral portion of the prothorax, posterior margin of pro-, meso-, and metapleurae, coxae and femora brown. Epimera and episterna of all three thoracic segments, trochanters, tibiae and tarsi yellowish-brown, connexivum luteous.

Length: 4-6 mm.

Locality: New South Wales: Bogan River, October 1931, J. Armstrong; Euralie, Narrandera Road, 9-19 October 1932, K. C. McKeown (A.M.); Broken Hill (S.A.M.); two, Coolabah, November 1905, W.G.B. (C.S.I.R.O.). Victoria: Melton, 25 October 1917, F.E.W. (S.A.M.). Bass Strait: Cliffy Island, 25 November 1949, D. J. Tugby (N.M.). South Australia: Tapanappa near Cape Jervis, 5-9 December 1949, G. F. Gross and N. B. Tindale; two, roadside swamp, Myponga, 26 November 1947, G. F. Gross; Yurgo, M. H. Hopgood; Port Wakefield; two, Flinders Island, F. Wood Jones; Ilka Creek, Flinders Ranges, 24 November 1948, D. R. Hall; Italowie Gorge, Flinders Ranges, 30 October 1955, E. T. Giles; Leigh Creek; Flinders Ranges, September 1925; twenty-five, Mooloolo, 2,000ft., Flinders Ranges, 1921, H. M. Hale; Upper Arcoona Creek, Gammon Ranges, 18 September 1956, G. F. Gross; Purple Downs; Miller Creek, F. Wood Jones; two, Blow Hole entrance, near Koonalda, 1 January 1960, P. Aitken (S.A.M.); Blowhole near Ooldea, Troughton and Wright (A.M.). Western Australia: Mullewa, Miss F. May; Beverley, E. F. du Boulay S.A.M.). Port Hedland, October, Mjöberg (R.M.S.). Northern Territory: Fourteen, Double Punch Bowl meteorite crater, Henbury, 15-17 October 1953, G. F. Gross; six, near Alice Springs,

M. W. Mules; Finke River, J. W. Roe; Coniston Station near Alice Springs, M. W. Mules (S.A.M.).

Udeocoris scudderi sp. nov.

Plate 16, fig. D

Black with dark brown and creamy white markings. Head shining black with a few long black hairs. Eyes, and first and last segments of antennae dark brown, third segment brown, second yellowish-brown.

Anterior two-thirds of pronotum likewise shining black with a few sparse long hairs, extreme anterior margin reddish-brown. Hind third creamy-white with scattered pale brown punctations.

Scutellum shining black, with sparse long black hairs, apex white.

Corium and clavus creamy-white in the main, with brown punctations, a small brown spot on clavus just behind middle. On corium two-thirds of the way back a wide transverse irregular brown band which may or may not be joined along the apical margin to the brown apical angle. Membrane when developed hyaline, otherwise hemelytra hardened and distinction between corium and clavus obscure.

Beneath shining black, punctate, pilose, hind margins of all thoracic pleurae, all epimera and episterna and connexivum creamy white. Anterior portion of prosternum reddish-brown. Coxae, trochanters, fore femora and apical halves of mid- and hind-femora dark brown, remainder of legs yellowish-brown, tarsi darker.

Length: 2.5-4 mm.

Locality: Western Australia: Holotype male, seven paratypes (three of them larvae), Beverley, E. F. du Boulay (S.A.M.). Victoria: Allotype female, fully winged, Lake Hattah, J. E. Dixon, donated January 1940 (N.M.). New South Wales: Paratype, Bogan River, January 1932, T. Armstrong (A.M.).

Differs from *U. rolandi* in its smaller size and the different pattern on the hemelytra.

Genus **Telocoris** gen. nov.

Head triangular, eyes not very prominent, touching anterior margin of pronotum. Pronotum a little wider than head with eyes, lateral margins faintly curved, obtuse, no trace of a transverse sulcus. Collar indistinct.

Scutellum relatively large, longer than wide. Hemelytra normal and fully developed, clavus with punctures in three regular rows.

Fore femora somewhat incrassate, without spines. Mid- and hind-femora not noticeably expanded. Fore-tibiae about as long as femora, hind-tarsi with first segment about as long as apical pair together.

Type of genus: *Telocoris vittata* (Distant)

This genus seems to stand naturally at the end of the line of these modified genera. The pronotum is absolutely without trace of a transverse constriction, the fore-femora although still somewhat thickened, are unarmed, and the habitus is much more like that of a Lethaeine than a Myodochine. Its nearest relation would appear to be *Udeocoris*.

Telocoris vittata (Distant) nov. comb.

Plate 15, fig. A.

Lamprodema vittata Distant, 1901: Ann. Mag. nat. Hist., (7) 8: 500.

Black or dark castaneous; hind angles of pronotum, antennae, basal two-thirds of corium and the whole anterior margin, outer half of clavus, and tibiae and tarsi, paler, almost luteous. Apical third of corium and inner half of clavus castaneous may be coarsely punctate, the latter then is laevigate along the central longitudinal area.

Length: 4-5 mm.

Locality: North Western Australia: Parry Harbour, Cape Bougainville, J. T. Walker (Distant's type—B.M.); Broome, Mjöberg (R.M.S.); Northern Territory: Roper River, N. B. Tindale (S.A.M.). Queensland: Clermont, K. K. Spence (A.M.).

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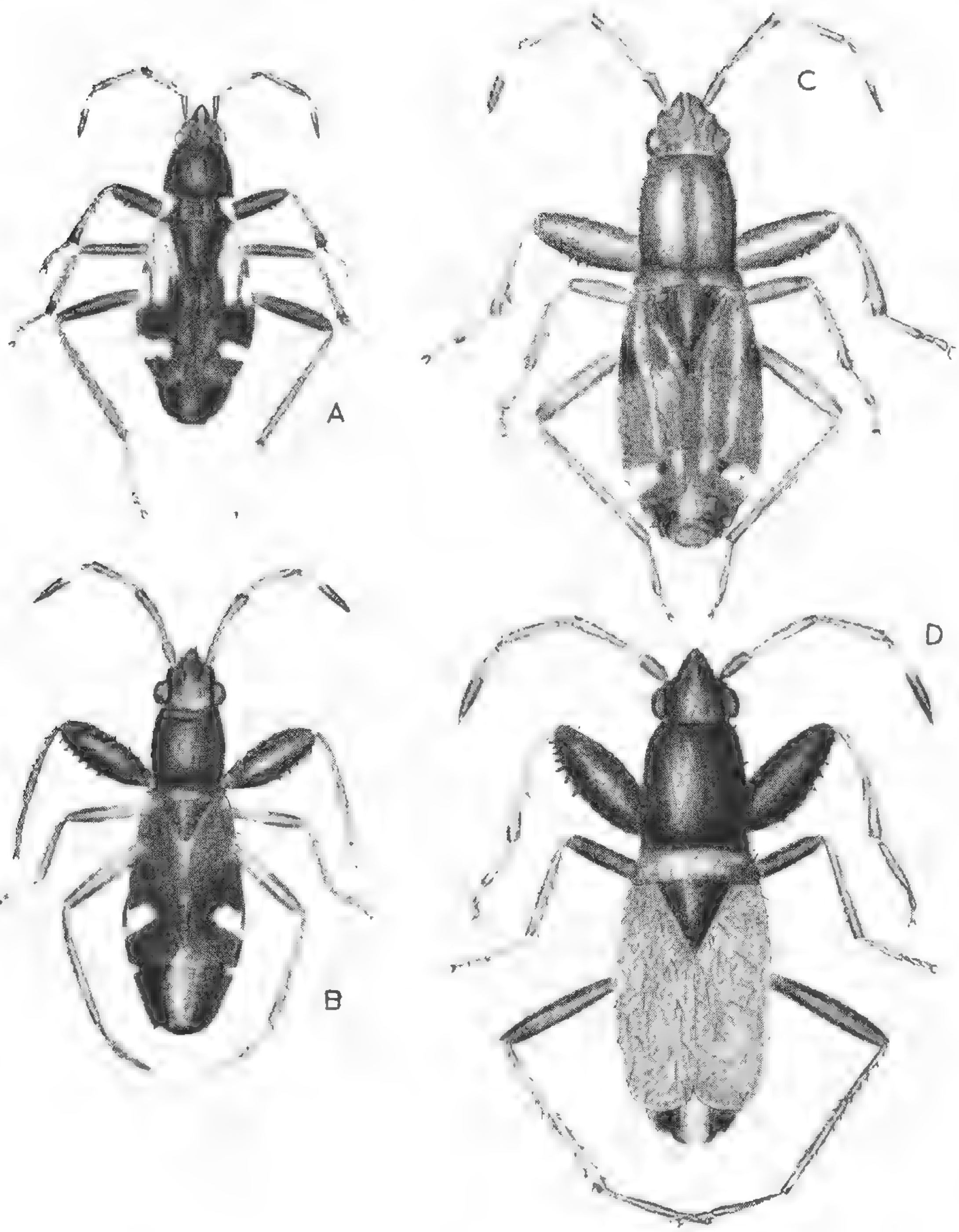

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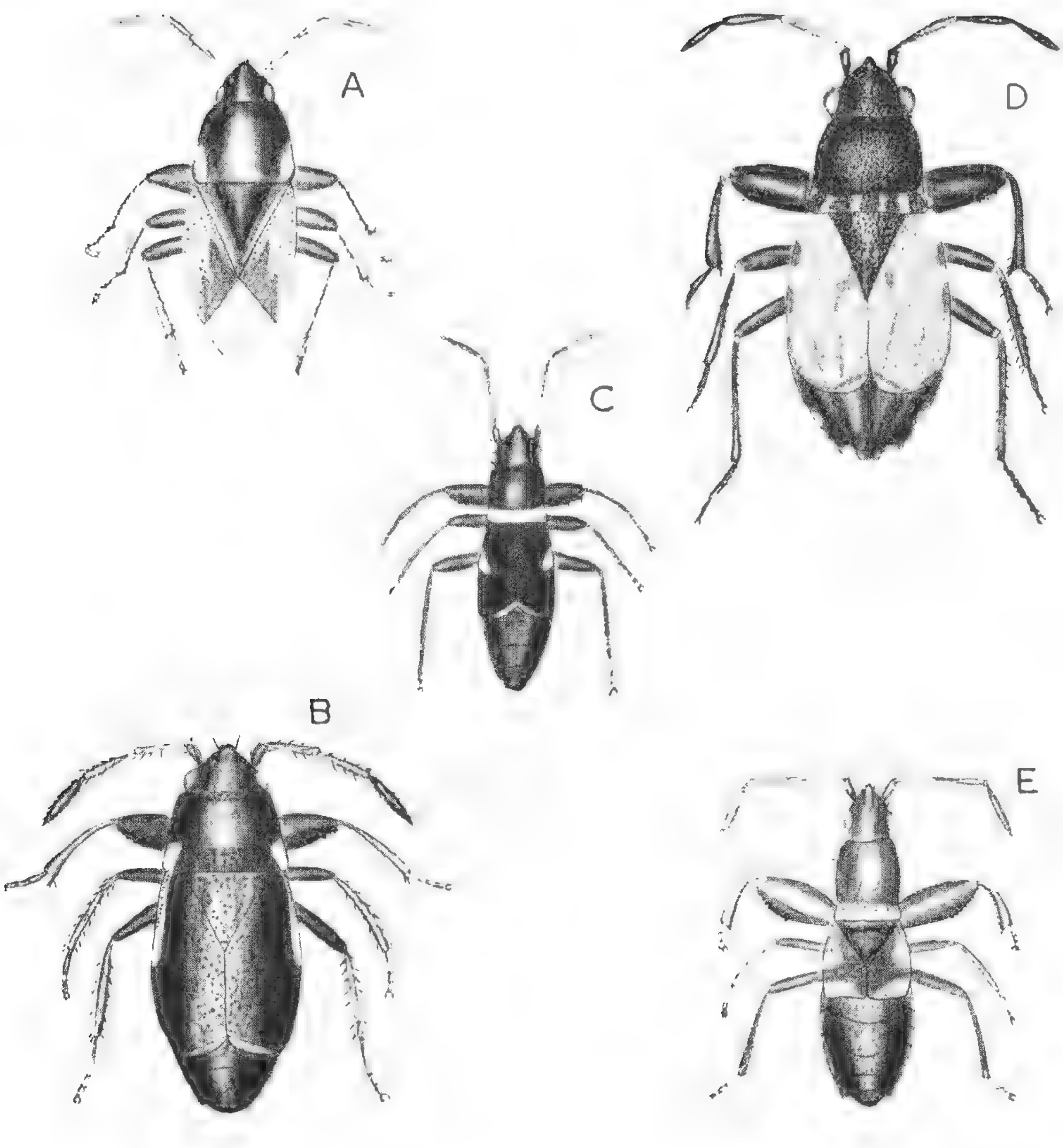
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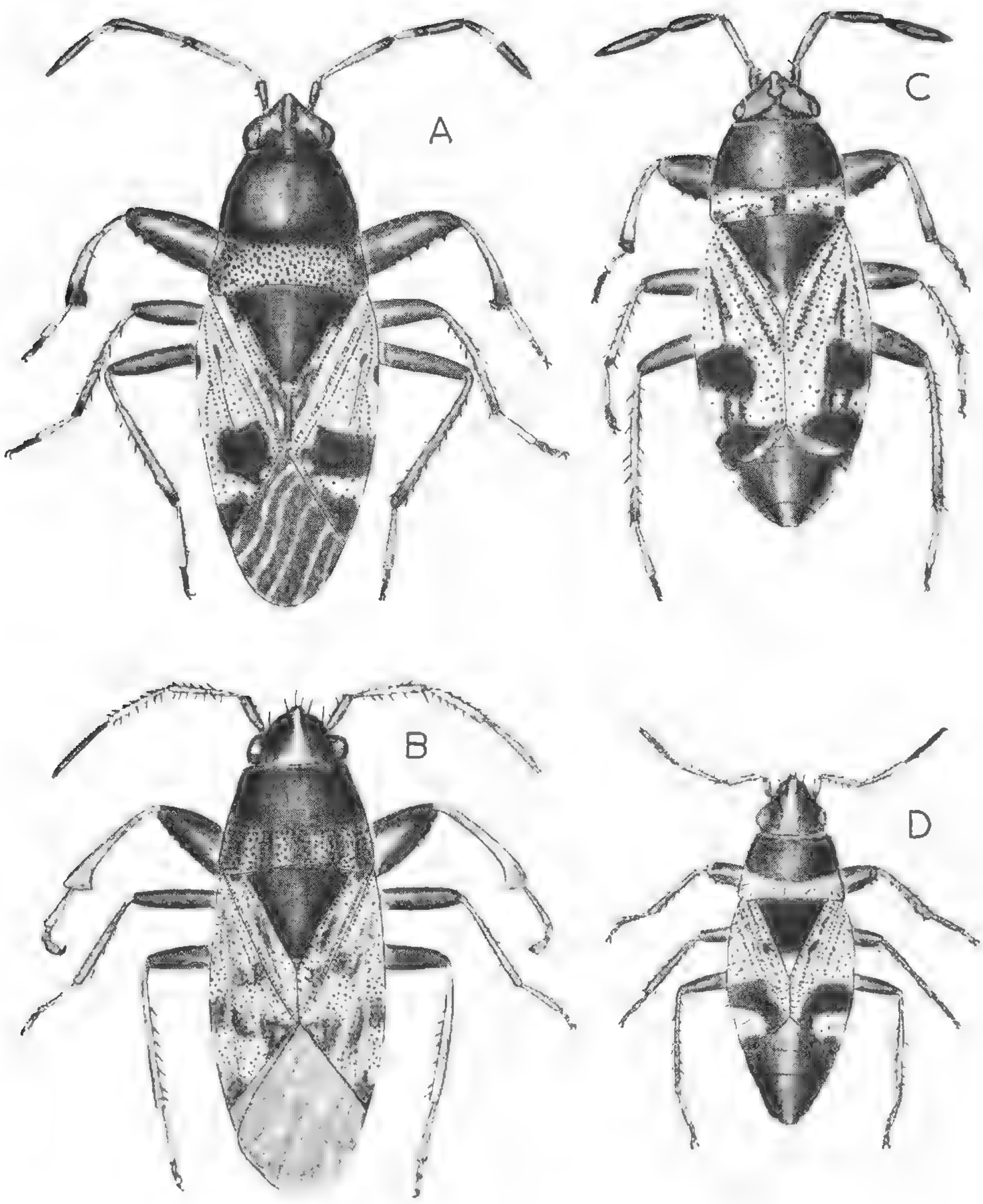
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SACRED OBJECTS OF THE PITJANDJARA TRIBE, WESTERN CENTRAL AUSTRALIA

BY CHARLES P. MOUNTFORD, HONORARY ASSOCIATE IN ETHNOLOGY, SOUTH AUSTRALIAN MUSEUM

Summary

This paper records twenty sacred objects (kulpidji) of the Pitjandjara tribe who inhabit the western deserts of central Australia. Seventeen of them are associated with Kikingura, the totemic place of the Windulka (mulga-seed) aborigines, on the western end of the Petermann Ranges, and three are from Katatjuta, a group of isolated monoliths about twenty miles west of Ayers Rock.

Being unable to visit Kikingura, the totemic place of the mulga-seed people, I could not link the designs on the kulpidji with the associated topography. To a limited degree, however, I was able to do so with those associated with Katatjuta, and even more fully with a series belonging to the totemic groups of Ayers Rock.(1)

SACRED OBJECTS OF THE PITJANDJARA TRIBE, WESTERN CENTRAL AUSTRALIA

By CHARLES P. MOUNTFORD, Honorary Associate in Ethnology, South Australian Museum

Fig. 1-5

INTRODUCTION

This paper records twenty sacred objects (*kulpidji*) of the Pitjandjara tribe who inhabit the western deserts of central Australia. Seventeen of them are associated with Kikingura, the totemic place of the *Windulka* (mulga-seed) aborigines, on the western end of the Petermann Ranges, and three are from Katatjuta, a group of isolated monoliths about twenty miles west of Ayers Rock.

Being unable to visit Kikingura, the totemic place of the mulga-seed people, I could not link the designs on the *kulpidji* with the associated topography. To a limited degree, however, I was able to do so with those associated with Katatjuta, and even more fully with a series belonging to the totemic groups of Ayers Rock.(1)

BELIEFS ASSOCIATED WITH THE *KULPIDJI*

Spencer and Gillen (1899, Chap. 5), give a particularly full account of the beliefs and functions of the sacred objects, the *churinga* (*tjurunga*) of the Aranda tribe of Central Australia, which, in some respects, perform the same functions as the *kulpidji* of the Pitjandjara.

Among other things, the Aranda believe that the child spirit leaves the *tjurunga* and entering the body of a woman that happened to be passing, starts life as a human being. At death, the spirit of the dead returns to the *tjurunga* from which it had emerged previously.(2)

My research into the Pitjandjara beliefs of conception and life after death, although far from complete, indicate that the *kulpidji* is neither associated with the life cycle of the Pitjandjara in the same manner as the *tjurunga* is with the Aranda, nor does it occupy such an important place in the philosophical beliefs.

(1) A description of the Ayers Rock *kulpidji* will be published elsewhere.

(2) For the purpose of this paper, this belief has been much simplified.

Nevertheless, the *kulpidji* of the Pitjandjara are objects of considerable sanctity and value. They are a record, in particularly limited symbolism, of the mythical beliefs of the tribe, and occupy an important part in the ceremonies (belonging to the same totem as the *kulpidji*), when the old men, laying the sacred object on the ground, relate the myth and explain the meaning of the designs engraved on its surface.

The aborigines, also, believing that the *kulpidji* is impregnated with a life essence (*kurunba* or *kurunita*; Mountford, 1948, pp. 111-113), often press the sacred objects against their body, believing that some of the *kurunba*, by leaving the *kulpidji*, and entering their body, gives them increased strength and vitality. The *kulpidji*, too, are particularly sacred, and all knowledge of them rigidly confined to the fully initiated men. Under no conditions must they be seen by the women or the uninitiated youths, or even mentioned within their hearing.

DESIGNS

Spencer and Gillen (1899, p. 145) when referring to the Aranda *tjurunga*, point out that "the whole design consists, with few exceptions, of a conventional arrangement of circular, semi-circular, spiral, curved and straight lines, together with dots". As one travels from central to north-eastern Australia, however, the concentric circles of the Aranda change, first to concentric squares, then to the interlocking key pattern, a characteristic of the art of north-western Australia (Davidson, 1937, p. 78, fig. 57).

The majority of the designs on the *kulpidji* in this paper are of the typical Aranda type, those on figs. 1 and 2 being typical. There are two examples of the concentric squares, fig. 3C, and 4GH (Davidson, 1937, fig. 55).

A number of the *kulpidji*, however, figs. 3AB, 3EF, 3D, 4CD, 5A, and 5B, are engraved with unusual designs which, so far as I am aware, previously have not been recorded. On these *kulpidji*, the irregular designs are outlined with shallow holes, about three-sixteenth of an inch in diameter, and the spaces of the designs filled in with a series of straight, parallel lines.

METHODS OF ENGRAVING

When carrying out research among the aborigines of the Ngadadjara tribe of the Warburton Ranges of Western Australia, I

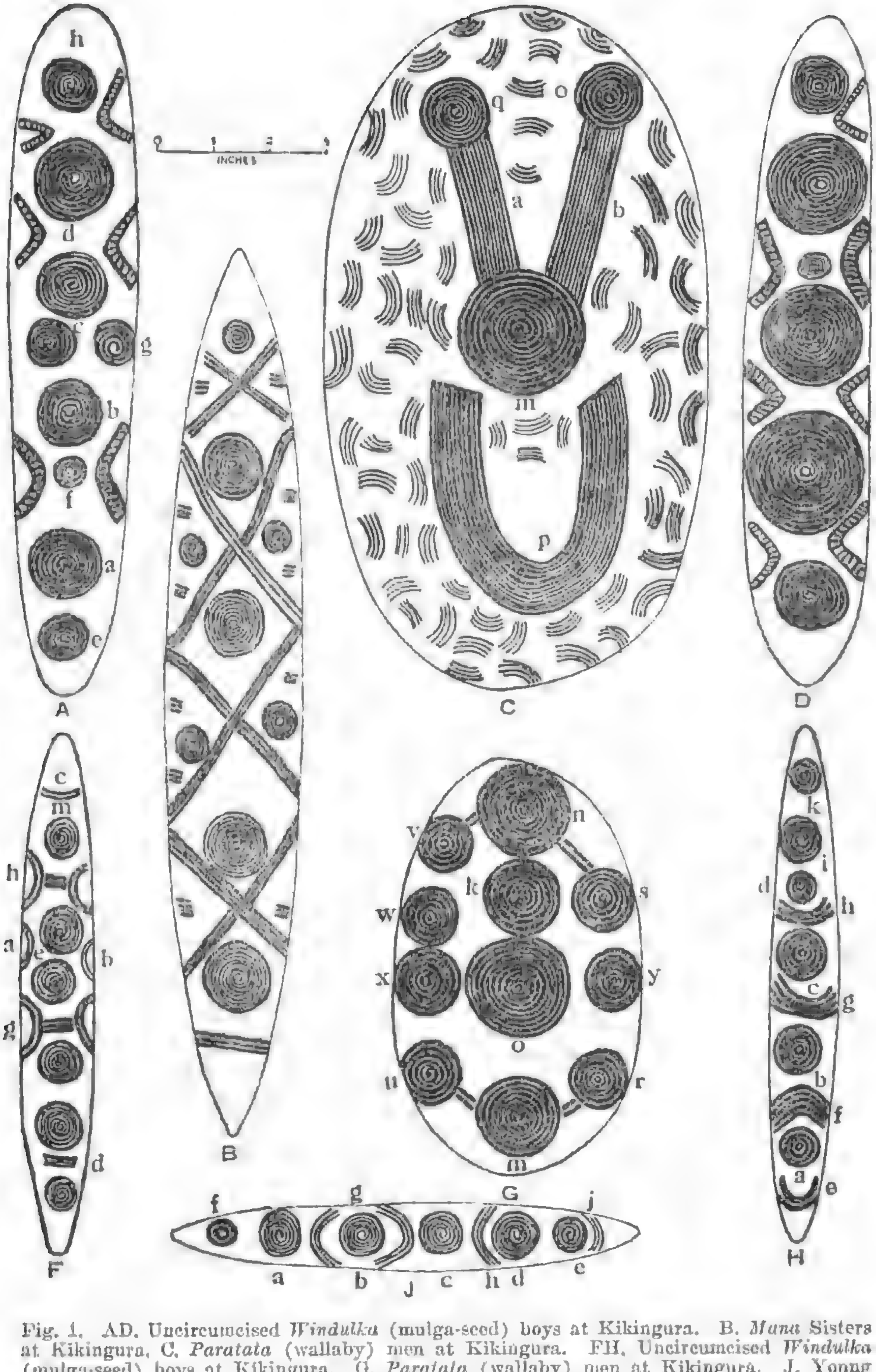

Fig. 1. AD. Uncircumcised *Windulka* (mulga-seed) boys at Kikingura. B. *Mana* Sisters at Kikingura. C. *Paratata* (wallaby) men at Kikingura. FH. Uncircumcised *Windulka* (mulga-seed) boys at Kikingura. G. *Paratata* (wallaby) men at Kikingura. J. Young *Windulka* (mulga-seed) boys at Kikingura.

watched an aboriginal engrave a spiral design on a spearthrower. Using, as an engraving tool, the incisor tooth of an opossum, still in the skull, the aboriginal held and operated the tool in somewhat the same manner as that of the modern engraver in metals. He was able to maintain such an efficient control over his primitive engraving tool that, not once, during the engraving of the design, did he allow the tool to slip and over-run his cut. Further east, however, the aboriginal engravers I have watched, apparently not so sure of their skill, placed their thumb-nail at the end of the cut to prevent any damage to the design should the tool slip.

DESCRIPTION OF SACRED OBJECTS FROM KIKINGURA

There are seventeen sacred objects (*kulpidji*) described in this paper that belong to the totemic place of Kikingura. They are:—

(A) The *Windulka* (mulga-seed) men, women and uncircumcised youths (eleven).
(B) The *Tjukula* men (one).
(C) The *Paratata* (wallaby) men (two).
(D) The *Mana* sisters (two).
(E) The *Kaduna* women (one).

(A) The *Windulka* (mulga-seed) People

Eight of the *kulpidji* belong to the adult mulga-seed people of Kikingura: (i) fig. 2DE; (ii) 2AH; (iii) 3CD; (iv) 3EF; (v) 4AF; (vi) 4BE; (vii) 4CD; and (viii) 4GH, and three to the uncircumcised boys: (i) 1AD; (ii) 1FH; and (iii) 1J.

(i) The *kulpidji* illustrated on fig. 2DE, pictures the camps of the mulga-seed women (the wives of the men shown on *kulpidja,* fig. 4GF).

On 2D, the three large groups of concentric circles, a, b, c, are the camps of the married women, and the four small groups, g, d, and h, e, their breasts. The double lines joining these groups of smaller concentric circles are the scars between the breasts of the women, and the smaller series of triple lines, mostly curved, that join the larger to the smaller concentric circles, the scars on their arms. The crescents on either end of the *kulpidji* represent the windbreaks of the camps of the mythical women.

On the reverse side of the *kulpidji* (fig. 2E), the larger groups of concentric circles represent the camps of the married women; the smaller a, b; c, d, their breasts, and the lines joining them, the scars between the breasts. The designs, u, t, are the windbreaks of the camps of the women, and the crescents on the edges of the *kulpidji*, the boomerangs of their husbands.

(ii) This *kulpidji* (fig. 2AH), illustrates a group of young and old *Windulka* men at Kikingura.

The larger groups of concentric circles on fig. 2A, represent the older *Windulka* men, and the smaller groups, the younger men. The lines joining the smaller circles together are the chest scars of the young men and the groups of short marks on the edge of the sacred objects, the scars on their upper arms. The curving lines throughout the whole of the engraved design represent the boomerangs of both the older and the younger men.(3)

On the reverse side (fig. 2H), the larger concentric circles, as before, are the old men, the smaller, the young men; the horizontal group of lines joining the smaller concentric circles, the chest scars and the triple groups of lines, the spearthrowers of both the old and the young men.

(iii) The engraved designs on this *kulpidji* (fig. 3CD), represent a group of Mulga-seed people travelling northward from a soakage at Kikingura.

Fig. 3D deals with the first section of that journey from the soakage at Kikingura to a spring in the side of a hill at Tjukula. The design b, on the top of 3D, is the soak at Kikingura, and a, on the bottom, the spring at Tjukula. The meandering design, W, running up the middle of the *kulpidji*, symbolises the track made by the mythical people as they travelled from one locality to the other, and the irregular shapes, on either side of the design W, the footmarks of the travelling people.

On 3C, the obverse side of the *kulpidji*, the larger groups of concentric squares represent groups of mulga-seed men at Kikingura sitting cross-legged in the ground. The smaller groups of concentric squares, q, m; p, n; and x, o, refer to twin peaks in the mountains of Kikingura.

(iv) The *kulpidji* illustrated by fig. 3EF refers to mythical mulga trees that grew at Kikingura during the time of creation.

The irregular designs on fig. 3E (made up of a series of holes drilled in the surface of the *kulpidji*, and filled with a series of

(3) This is a point of some interest, because the Pitjandjara aborigines do not use the boomerang.

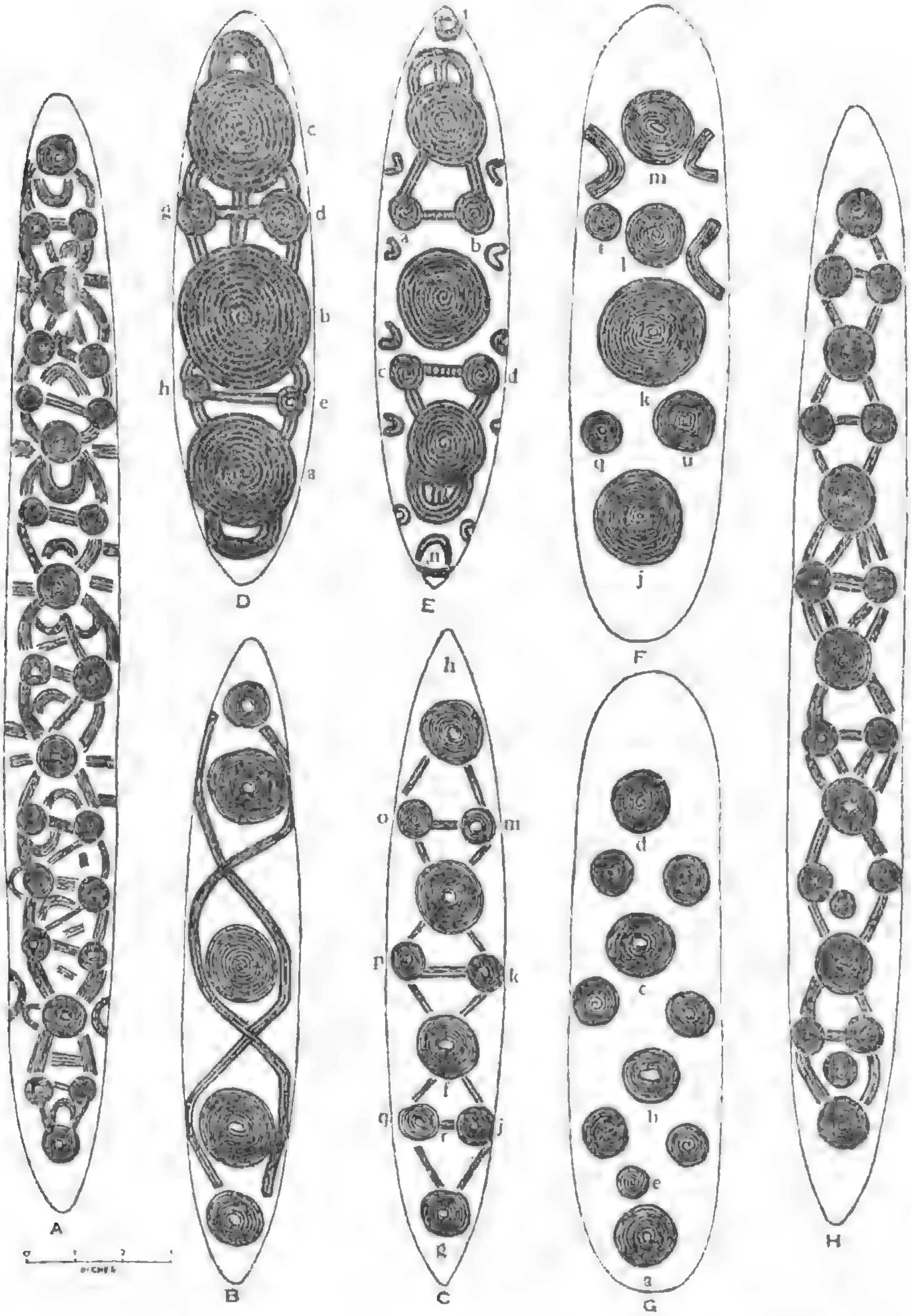

Fig. 2. AH. Old and young *Windulka* (mulga-seed) men at Kikingura. BC. *Mana* Sisters at Kikingura. DE. *Windulka* (mulga-seed) women at Kikingura. FG. *Kaduna* women at Kikingura.

parallel lines), symbolise groups of *Windulka* men sitting quietly in their camps at Kikingura. The design, o, on the top, indicate a group of living mulga trees (almost certainly of totemic importance).

On the other side of the *kulpidji* (fig. 3F), the irregular designs (similar to those on 3E), indicate the camps of the Mulga-seed men at Kikingura and the short meandering design at k, a track made by the people as they walked from camp to camp.

(v) The *kulpidji* illustrated on fig. 4AF, refers to a number of Mulga-seed men who had always camped at Kikingura. The series of concentric circles on both sides of this *kulpidji* show the adult men seated in their camps; the vertical parallel lines, the spearthrowers of the *Windulka* men leaning against their windbreaks, and the diagonal lines, the men carrying their spearthrowers in the crooks of their arms. The designs on the top of fig. 4A illustrate the boomerangs and shields of the men.

(vi) Fig. 4BE illustrate a group of *Windulka* men and boys in their camp at Kikingura. The largest groups of concentric circles on both sides of the *kulpidji* are the camps of the adult men; the intermediate size, those of the adolescent youths ready for initiation, and the smallest, very young boys.

The central group of triple lines on the sides of both 4B and E, indicate the spears of the aborigines, and the diagonal lines, their spearthrowers. There is a slight variation in the design on fig. 4E, the horizontal groups of lines representing the chest scars on the bodies of the men and the older boys.

(vii) Fig. 4CD also deals with the mythical Mulga-seed men camping at Kikingura. The irregular designs at fig. 4C symbolise groups of men seated on the ground and the curvilinear lines on the top of the *kulpidji,* their windbreaks. The lines of holes separating the groups of parallel lines, indicate the piles of mulga seed which had been collected by the wives of the mythical mulga-seed men.

The designs on the reverse side (fig. 4D), represent mulga trees, the seed of which, during the early days of the world, fell to the ground in such quantities that the men and women of those times always had an abundance of food. As on the obverse side (fig. 4C), the lines of holes on the surface of the *kulpidji* symbolise piles of mulga seed.[4]

[4] Mulga seed when ground into flour, made into a cake and baked in the ashes of the camp fire, is a favourite food of the aborigines.

(viii) Both sides of the *kulpidji* illustrated on fig. 4GH have identical meanings. The diamond shapes indicate the camps of the Mulga-seed men and women at Kikingura, the lines of holes, the sticks in the windbreaks of the camps, and the horizontal parallel lines, the scars on the upper arms of the men.

Three *kulpidji*, figs. 1AD, 1FH, and 1J, deal with the mythical uncircumcised boys of Kikingura.

(i) On fig. 1AD, the larger of the concentric circles, a, b, c, d, on fig. 1A, are the camps of the elder uncircumcised boys (called *bulgu* at this stage of their life), and the groups e, f, g, h, those of the younger boys. The triangular patterns on the borders of the *kulpidji* symbolise the boomerangs of the older boys. The designs on the reverse side (fig. 1D), although slightly different, have similar meanings.

(ii) Fig. 1FH also deals with the mythical uninitiated Mulga-seed boys at Kikingura. The concentric circles on the obverse side (fig. 1F), are the boys in their camps, and the two designs at g and h, pairs of boys playing see-saw on a log balanced across a tree trunk. The boomerangs of the youths are indicated at a, b, and c; and their body scars by group of triple lines at d.

On the reverse side of fig. 1H, the series of concentric circles, a, b, c, d, are the camp-fires of the mythical youths and the groups of curved lines e, f, g, h, the boys lying beside their fires. The groups of concentric circles at i, k, indicate other boys resting in the shade of the trees.

(iii) On the third *kulpidji* of the mythical boys (fig. 1J), the groups of concentric circles, a, b, c, d, etc., are the camp fires, and the groups of curving lines, g, h, and j, the uninitiated boys warming themselves beside those fires. The smallest circle, f, on the extreme left represents a small child sitting by himself.

(B) The *Tjukula* Men

One *kulpidji* (fig. 3AB), over five feet long, deals with the journey of a group of mythical (unidentified) *Tjukula* men. The obverse side (fig. 3A), illustrates a journey from Kikingura northward to Tjukula, where there is a spring of that name in the side of a hill, and the reverse side, the journey from Tjukula to a rock-hole called Pulitjilda. From this point, according to my informants, which was the end of the Tjukula line of songs, the mythical men "flew" away, and the owners of the *kulpidji* had no further knowledge of them.

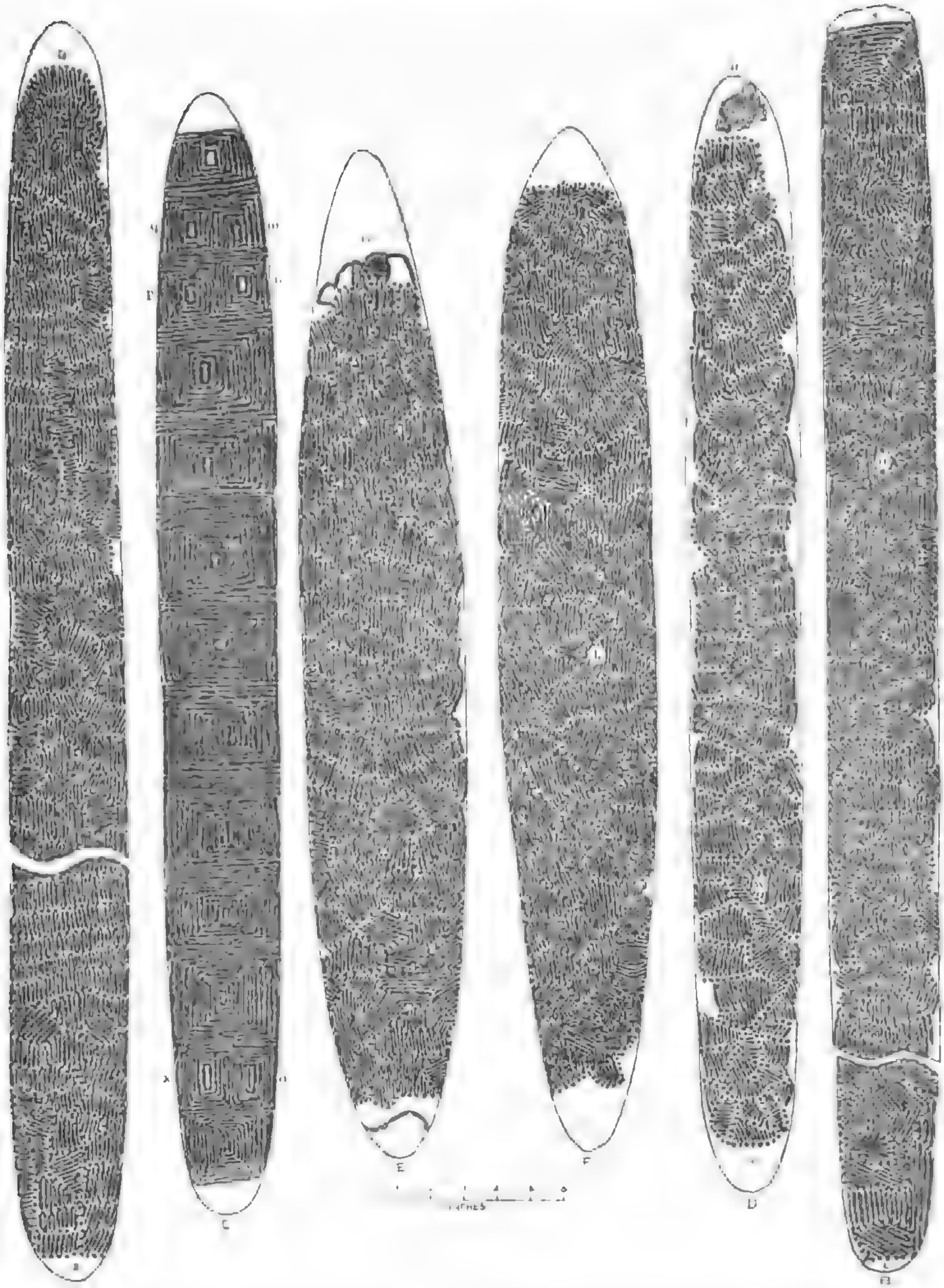

Fig. 3. AB. Journey of *Tjukula* men from Kikingura. CD. *Windulka* (mulga-seed) men at Kikingura. EF. *Windulka* (mulga-seed) men at Kikingura.

On fig. 3B, the meandering pattern, o, outlined with small holes and filled in with short parallel lines, symbolises the track made by the mythical *Tjukula* men as they travelled from Kikingura, a, to Tjukula, c. The irregular designs covering the remainder of the *kulpidji* represent the tracks made by the *Tjukula* men as they travelled from one locality to the other.

The other side of the *kulpidji* (fig. 3A), the irregular patterns represent the footmarks of the Tjukula men as they continued their journey from the spring at Tjukula, a, to the rock-hole at Pulitjilda, b.

(C) The Wallabies, *Paratata*

Two *kulpidji*, figs. 1C and 1G, belong to the totem of the mythical wallaby (*Paratata*) men. These mythical creatures, relatives of the Mulga-seed men, lived permanently at Kikingura.

(i) Fig. 1C, a beautifully-engraved, stone *kulpidji*, deals with an old wallaby man at Kikingura. The concentric circles at m is the place where the *Paratata* man once camped. The circles, q and o are his feet, and the groups of parallel lines a, b, his legs. The U-shaped design, p, was once his windbreak, and the groups of crescents, young wallabies lying down. It is likely, although my informants did not say so, that these young wallabies were the children of the old man.

The camp of the wallaby is now a large spring of water; his feet are two rock-holes; his legs, stony ridges, and the bodies of the young wallabies, outcrops of stones.

(ii) On the small stone *kulpidji* (fig. 1G), the concentric circles at m, n, are places at Kikingura where a *Paratata* man once camped. At u, r and v, s, are his feet, and the parallel straight lines joining them to m and m respectively, his legs. The designs, k, w, x and y, are the painted decorations on the back of the *Paratata* man. The designs on this side of the *kulpidji,* like those on fig. 1C, almost certainly refer to topographical features.

(D) The *Mana* Sisters

Two *kulpidjis* (fig. 1B and fig. 2BC), deal with the *Mana* sisters who lived at Kikingura during creation times.

(i) The four series of concentric circles, on fig. 1B, are the *Mana* women sitting on the ground; the triple diagonal lines, symbolising their legs. The smaller pairs of circles, indicate their breasts; the short transverse lines along the edge of the *kulpidji*, the scars on their chests, and the triple parallel horizontal lines, the windbreak behind which the *Mana* women slept. The engraved designs on the reverse side have similar meanings.

(ii) The four large groups of concentric circles on fig. 2C, again represent the *Mana* women seated on the ground; the paired groups of concentric circles, q, j; p, k; and o, m, their breasts, and the short transverse lines joining the smaller circles their chest scars. The diagonal lines on this *kulpidji* represent the outstretched legs of the women (see fig. 1B).

On fig. 2B, the five series of concentric circles represent the *Mana* women sitting down and the meandering lines, the hair-string ornament which the women wore around their neck and over their shoulders.

(E) The *Kaduna* Women

The *kulpidji* (fig. 2FG), belongs to a group of *Kaduna* women, the wives of the Mulga-seed men (see fig. 3CD).

The large concentric circles j, k, on 2F, are two of the *Kaduna* women; q, u, and t, l, their breasts and the three crescent designs on the upper part of the *kulpidji*, the scars on their arms. The body of a third *Kaduna* woman is indicated at m.

On the reverse side (fig. 2G), a, b, c, d, are places where four of the adult *Kaduna* women sat down and e, that of a young girl. The paired concentric circles are the breasts of the older women.

SACRED OBJECTS FROM KATATJUTA

Three *kulpidji* are associated with Katatjuta, a group of enormous domes of rock about twenty miles west of Ayers Rock, the highest of them, Mount Olga, rising to almost eighteen hundred feet above the surrounding plain. One *kulpidji* (fig. 5A), belongs to the myth of the giant *Pungalunga* men of the western side, and two, fig. 5B and 5C, to the mythical *Mingiri* (brown desert mouse) women of the eastern face.

(A) The *Pungalunga* Men

(i) The irregular designs, j, k, l and m, on one side of fig. 5C (the other side is plain) symbolise the footmarks of the giant *Pungalunga* men of creation times, whose camps, at the close of the "creation" period, were transformed into a series of huge monoliths on the western side of Katatjuta. Mountford (1948, p. 98) gives a

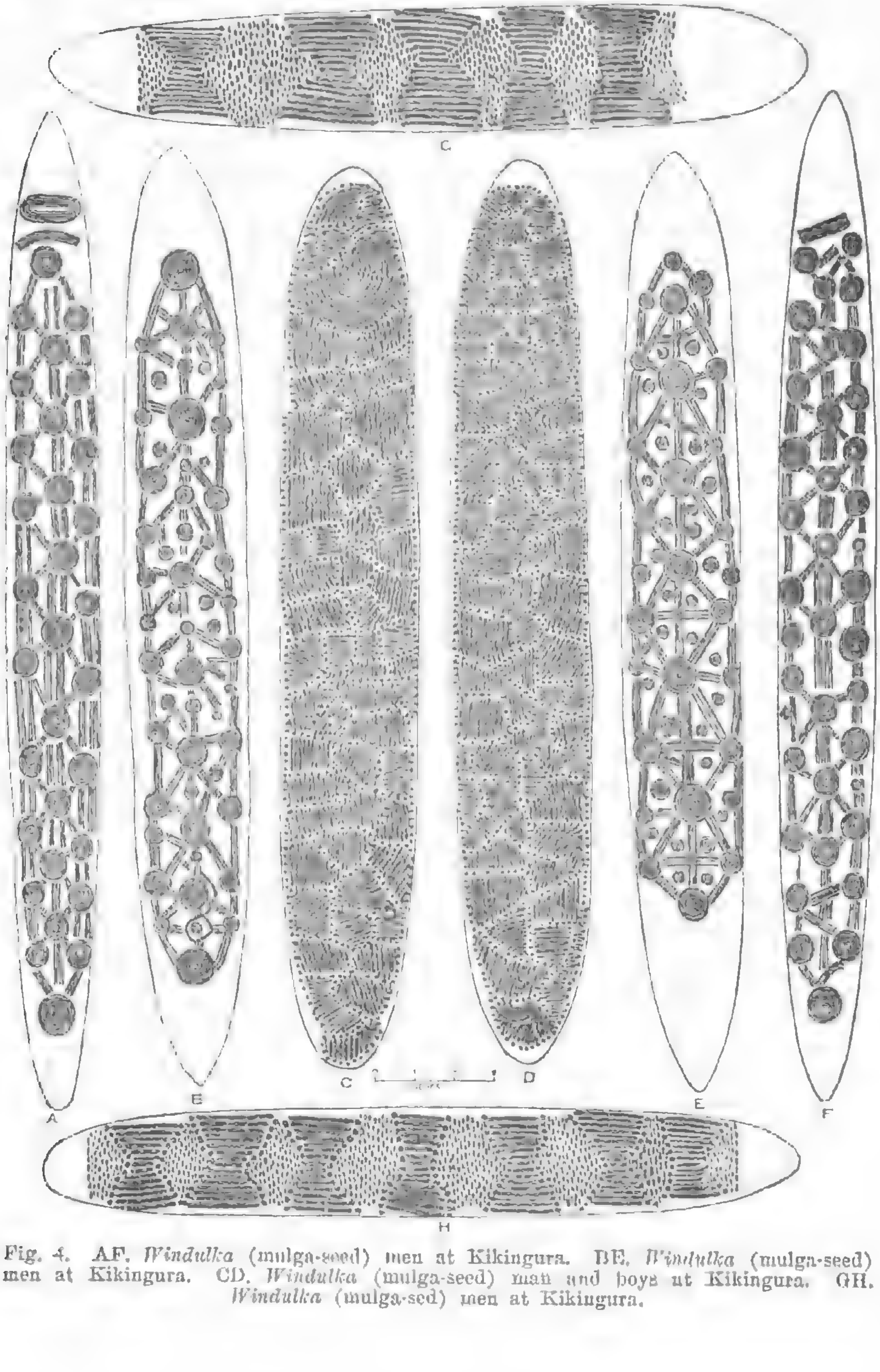

Fig. 4. AF. *Windulka* (mulga-seed) men at Kikingura. BE. *Windulka* (mulga-seed) men at Kikingura. CD. *Windulka* (mulga-seed) man and boys at Kikingura. GH. *Windulka* (mulga-sed) men at Kikingura.

short description of the *Pungalunga* myth. The engraved rectangles at a, b, c, etc., and g, h, i, refer to unidentified trees associated with the *Pungalunga* myth.

(B) The *Mingiri* Women

Two *kulpidji* (fig. 5A and fig. 5B), belong to the myth of the *Mingiri* (mice) women who lived on the eastern side of Katatjuta.

(i) The *kulpidji*, 5A, like 5B, is engraved only on one side. The meandering design, a, along the middle of the *kulpidji* represents a watercourse at Katatjuta, called Gundundura, which is associated with the myth of the *Mingiri* women. The irregular patterns are piles of the yellow-fruited solanum *jirtunba*, which the *Mingiri* women collected as food. At the close of the creation period these piles of food were transformed into high rocky monoliths.

(ii) Fig. 5B is a *kulpidji* with a series of simple circles that is associated with the *Mingiri* myth of Katatjuta. Those at a, a, represent the camps of the women; b, b, the breasts of one of the women; c, c, a pregnant *Mingiri* woman who gave birth to her child, d, d, under the mulga trees, e, e.

At present, a, a, are high rocky domes, b, b, patches of level ground, c, c, small rock-holes, d, d, a cave and e, e, mulga trees.

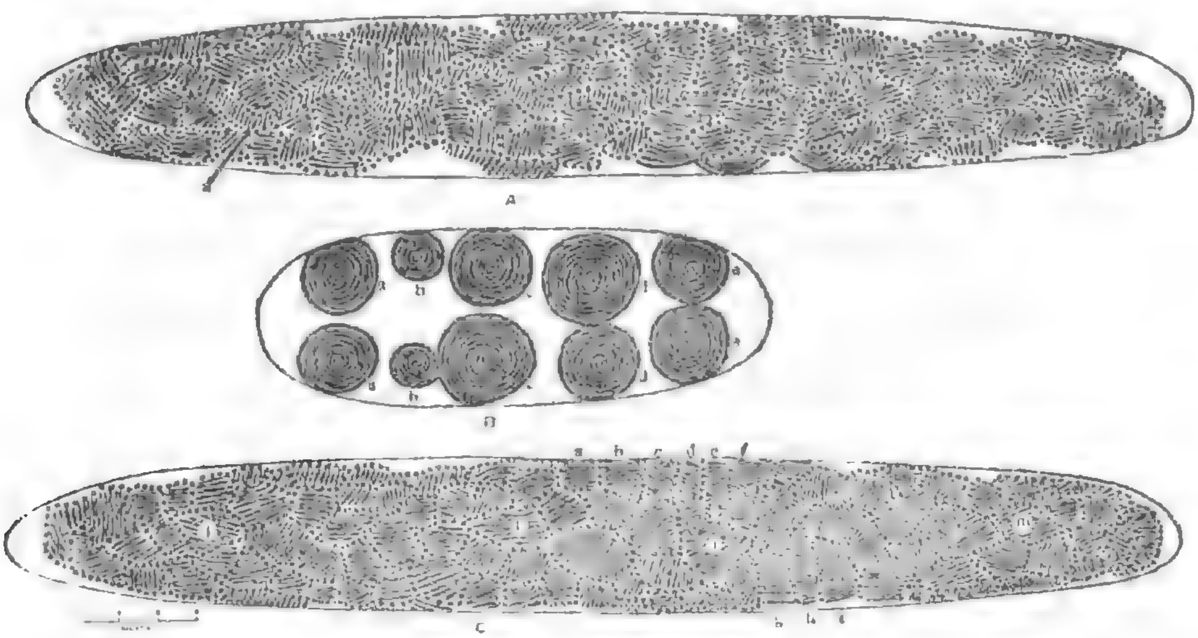

Fig. 5. Katatjuta. AB. *Mingiri* (mice) women at Katatjuta. C. *Pungalunga* men at Katatjuta.

DISCUSSION

An examination of the Pitjandjara *kulpidji* and of others I have studied among the Aranda, Ngalia and Walpiri (Wailbri) tribes of Central Australia has shown that the aborigines of this area use a remarkably limited number of art motifs to illustrate the mythical stories they engrave on their sacred objects, motifs which are particularly simple, being almost entirely limited to circles, spirals, parallel straight and meandering lines, rows of dots, and little else. Figs. 1 and 2 in this paper are typical of these motifs.

Among the *kulpidji* of the Pitjandjara, however, are two different motifs, concentric squares, fig. 3C and 4GH, and another curious and previously unrecorded motif, *i.e.*, 3AB, 3EF, etc. The motifs on these *kulpidji* are even more limited than the curvilinear designs on the remainder.

This paucity of design elements has meant that the same motif, will, on different and sometimes on the same *kulpidji*, have different meanings. Until, however, we have a much wider range of fully interpreted *kulpidji* or other sacred objects available for study, it is not possible to make an analysis of the designs and to find out the stability, or otherwise, of any particular motif.

TECHNIQUES OF RECORDING

The method employed for recording the engraved designs was to first make a rubbing with black lumber crayon of the design on strong tissue paper. On this rubbing I wrote the meanings of the engraved designs and in my field note book, details of the associated myth.[5]

The drawings on figs. 1-5 were traced from the rubbings made in the field. By this method, a much more accurate record is possible than by any other means.

ACKNOWLEDGMENTS

I wish to acknowledge my indebtedness to the Minister for Territories (The Hon. Paul Hasluck, M.P.) and his staff for their unstinted help in making this research possible, to the South Australian Museum for the use of their facilities, and to Miss Brenda Hubbard for her excellent drawings of the *kulpidji*.

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(5) Although the aborigines were willing to part with the majority of these sacred objects, departmental regulations did not allow me to accept them. However, the rubbings and the associated data gave me the information I required.

SUMMARY

This paper records the designs, the meanings, and to a limited degree, the myths belonging to twenty-one sacred objects of the Pitjandjara tribe of western central Australia.

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VOLUME 14 No. 3

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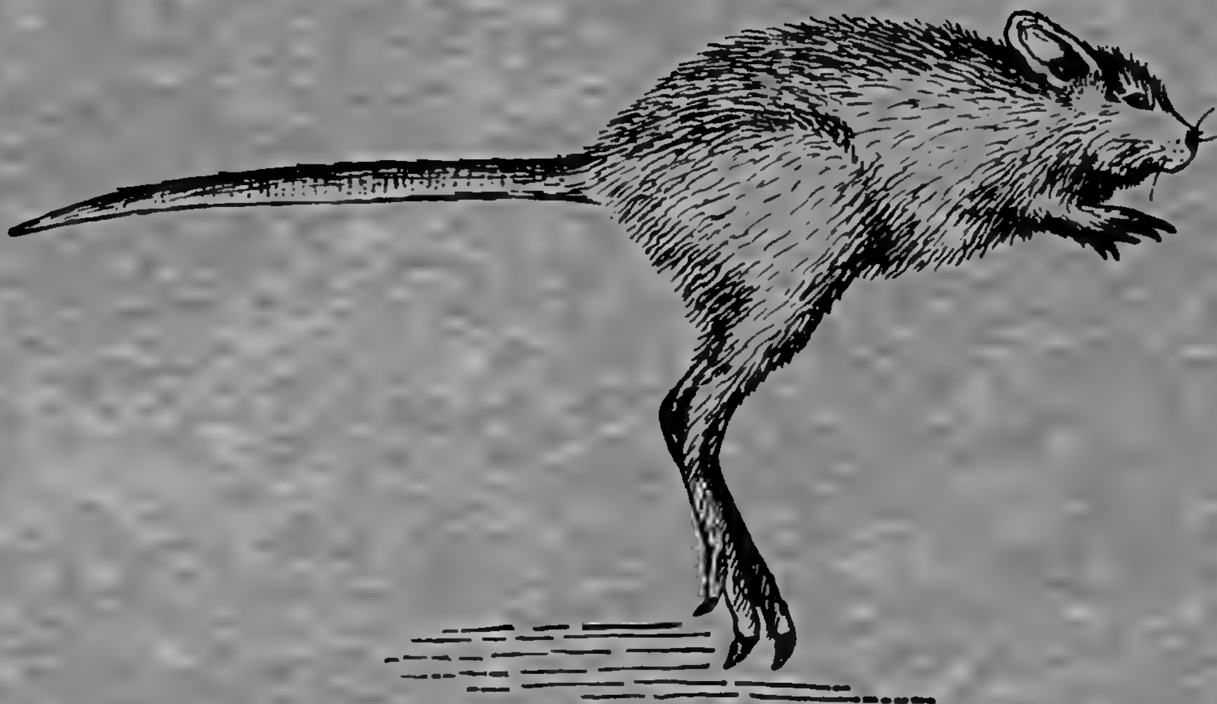

RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

Published by the Board and edited by Norman B. Tindale

Printed in Australia by W. L. Hawes, Government Printer, Adelaide.

Registered in Australia for Transmission by Post as a Periodical.

FOSSIL RATITE BIRDS OF THE LATE TERTIARY OF SOUTH AUSTRALIA

By Alden H. Miller, Museum of Paleontology, University of California

Summary

Two kinds of ratite birds occur in the late Tertiary of the Lake Eyre region of Australia. These fossils are part of the Palankarinna fauna, tentatively referred to the early Pliocene, and were found in the Mampuwordu Sands at Lake Palankarinna. One specimen is described as a new species of emu, Dromiceius ocypus, which shows foot specialization equivalent to that of the modern emus of the continent. It is a smaller species than the living emu of the area but has foot proportions like the even smaller insular species of Pleistocene and Recent times. The other specimen is a fragmentary pelvis which is referred to the genus Genyornis. It is equivalent in size to the giant extinct Genyornis newtoni of the Pleistocene.

The fossils here reported extend the paleontologic record of the avian families Dromiceiidae and Dromornithidae from the late Pleistocene back to the Pliocene.

FOSSIL RATITE BIRDS OF THE LATE TERTIARY OF SOUTH AUSTRALIA

By ALDEN H. MILLER, Museum of Paleontology, University of California

Fig. 1-2

SUMMARY

Two kinds of ratite birds occur in the late Tertiary of the Lake Eyre region of Australia. These fossils are part of the Palankarinna fauna, tentatively referred to the early Pliocene, and were found in the Mampuwordu Sands at Lake Palankarinna. One specimen is described as a new species of emu, *Dromiceius ocypus*, which shows foot specialization equivalent to that of the modern emus of the continent. It is a smaller species than the living emu of the area but has foot proportions like the even smaller insular species of Pleistocene and Recent times. The other specimen is a fragmentary pelvis which is referred to the genus *Genyornis*. It is equivalent in size to the giant extinct *Genyornis newtoni* of the Pleistocene.

The fossils here reported extend the paleontologic record of the avian families Dromiceiidae and Dromornithidae from the late Pleistocene back to the Pliocene.

INTRODUCTION

The discovery of Tertiary fossil-bearing deposits in the Lake Eyre basin of South Australia was made known in 1954 by R. A. Stirton. One of the fossil assemblages found was of late Tertiary age and has been tentatively referred to the early Pliocene. It has been designated the Palankarinna fauna (Stirton, Tedford, and Miller, 1961, p. 37). In our preliminary listing of this fauna, a ratite bird was mentioned (p. 38). This may now be described as well as an additional ratite from the same formation that was obtained in the course of the field expedition of 1961.

ACKNOWLEDGMENTS

Work on fossil vertebrates of South Australia has continued to receive the generous support and encouragement of the South

Australian Museum and its staff. In 1961 we were especially aided by Mr. Norman B. Tindale and Paul F. Lawson and in the field by Lawson and Harry J. Bowshall. The expedition in that year was made possible by a grant from the National Science Foundation of the United States. For opportunity to examine Pleistocene and Recent emu bones I am indebted also to Edmund D. Gill and Allan McEvey of the National Museum of Victoria, Melbourne, and to H. T. Condon of the South Australian Museum.

DESCRIPTIONS

Family DROMICEIIDAE

The tarsometatarsus of an emu was obtained at the Lawson Quarry (U.C.M.P. locality V 5769) at Lake Palankarinna in 1957. It is essentially complete and lacks only the tip of the intercotylar prominence. The surface of much of the shaft is checked and in places eroded, but the distal articular area is complete and well preserved as is the hypotarsus. The shapes and relative sizes of the trochleae, the configuration of the plantar surface, the presence and location of the distal foramen, and the details of the hypotarsus all conform to those of the modern emus (*Dromiceius*) and in no respect suggest the conditions in the cassowaries (see fig. 1). The shortness and relative stoutness of the fossil is somewhat like the condition in cassowaries (*Casuarius unappendiculatus*) but in proportions it is even closer to the extinct forms of Recent and Pleistocene emus of the islands off the southern border of the Australian continent, namely *Dromiceius diemenianus* and *Dromiceius minor*.

Comparisons have been made with seven skeletons of the modern emu of the continent, *Dromiceius novae-hollandiae*, and with measurements I have taken of 14 tarsometatarsi of *minor*, including those labelled as "hypotypes" at Melbourne and with two complete tarsometatarsi of *diemenianus* in the South Australian Museum. The measurements show that the Pliocene emu was significantly shorter-legged than the modern continental bird and larger than the insular forms while possessing the relatively greater width of the latter. The Pliocene species may be known as:

Dromiceius ocypus sp. nov.

Type: Right tarsometatarsus, essentially complete. South Australian Mus. No. P 13444; Univ. Calif. Mus. Paleo. locality No. V 5769, Mampuwordu Sands, Lake Palankarinna, late Tertiary, apparently early Pliocene.

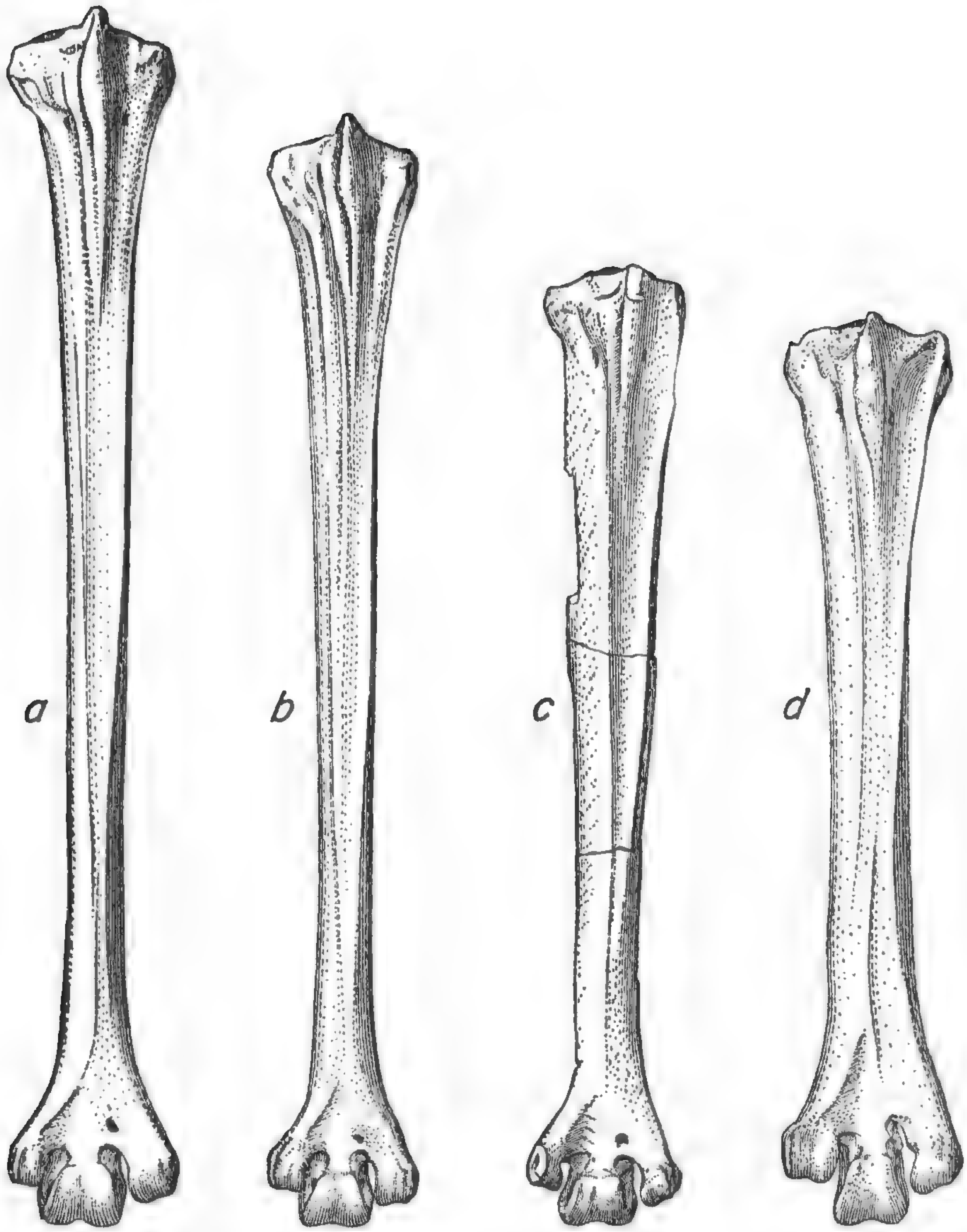

Fig. 1. Right tarsometatarsi of emus and cassowaries, plantar view, × ⅓. *a. b. Dromiceius novae-hollandiae,* large and average individuals. *c. Dromiceius ocypus,* type. *d. Casuarius unappendiculatus.*

Diagnosis: Similar in foot structure to *Dromiceius novae-hollandiae* but relative breadth of distal end of tarsometatarsus greater and linear dimensions less. Ratio of width across trochleae to length of tarsometatarsus 15.7 per cent as contrasted with 13.3 to 14.5 (average 13.6) per cent in *novae-hollandiae* and length 15 per cent less.

Analysis and comparison: Individual variation in size in emus is rather great as casual examination reveals. One can readily set aside the tarsometatarsi of individuals that are not yet fully grown by reason of the evidence of immaturity in the incomplete fusion of the tarsal region, the imperfect ossification in the area of the distal foramen and at the junction of the trochleae, and the roughness of the surfaces of the shaft. But even in bones of adults linear dimensions show considerable range of variation. For example, the coefficient of variation in tarsal length of the seven adult modern emus is 4.6 per cent. The bones of *Dromiceius minor* and of *D. diemenianus* represented in table 1, as well as the tarsometatarsus of *D. ocypus*, are those of adults. The departure of the fossil from the modern emu in tarsal length and relative width of the distal end of the tarsometatarsus was found to be significant (t test, $P = < 0.02$ and < 0.01, respectively).

Although the individual measurements of the series of *Dromiceius minor* were not recorded, the range of the 14 specimens and the values for *D. diemenianus* are such that there seems to be no possibility of overlap of either with *D. ocypus*. The latter exceeds the maximum of *D. minor* by 4.7 cm. or 16 per cent. The ratio of the width across the trochleae to tarsal length is, however, the same in *minor*, *diemenianus*, and *ocypus*.

Table 1

Measurements of Tarsometatarsi of Emus (*Dromiceius*) in Millimeters

	D. novae-hollandiae (7 specimens)		*D. ocypus*	*D. minor* (14 specimens)		*D. diemenianus* (2 specimens)	
	Mean and Range	Standard deviation (N-1)		Minimum	Maximum		
Total length	399 (377-431)	18·2	337·0	231·0	290·0	252·0	250·0
Distal width across trochleae	54·5 (51·0-58·9)	2·8	53·2	42·0	45·0	42·7	42·8
Proximal width	53·2 (51·1-56·7)	2·4	50·5	36·5	42·0	35·8	37·8
Least depth of shaft	13·5 (12·5-14·8)	0·85	12·6	8·4	10·5	10·4	9·9
Ratio of distal width to length (per cent)	13·6 (13·3-14·5)	0·46	15·7	15·5	16·6	17·0	17·1

Three names have been created for late Pleistocene emus from the continent of Australia by De Vis (1884, 1888, 1892). Two of these are based on very unsatisfactory fragments. *Dromiceius queenslandiae* (De Vis, 1884) is known from a proximal part of a left femur. Hutton's report (1893) on this brings out characteristics of shape which seem to relate it either to the emus or the Dromornithidae rather than to the moas, contrary to the original view of the describer. Oliver (1949, pp. 80-88, 183) makes no appraisal of Hutton's allocation and returns *queenslandiae* to the moas. Oliver's photographs and description of this fossil compared with bones of moas (*Pachyornis*), emus, and cassowaries at hand do not convince me that his assignment is well established. In any event the bird was roughly 50 per cent larger than *Dromiceius novae-hollandiae* and thus it is wholly distinct from *D. ocypus*.

Dromiceius gracilipes (De Vis, 1892) was based on a very fragmentary distal end of a tarsometatarsus that should never have been named. Because it lacks the distal tarsal foramen characteristic of emus, it may not even belong to this group. The figure of it suggests that there has been considerable abrasion of the specimen and therefore evidence of immaturity may have been lost. The specimen could have been part of an immature emu in which the distal foramen had not yet formed, or it could be from a small cassowary. Clearly it has no close affinity with *D. ocypus*.

Dromiceius patricius (De Vis, 1888) was based on a tibiotarsus; a coracoid was also described and provisionally referred to it. The tibiotarsus was stated to reflect a heavier, more muscular leg than that of the modern emu. De Vis' description of differences in configuration leave one in doubt as to their significance, and examination of his figures of tibiotarsal fragments gives no assurance of the validity of the differences. The size of *patricius* as measured from the figures is not greater than in large individuals of modern emus, nor is the bone heavier. Much other Pleistocene material has been referred to *patricius*, including remains from the Pleistocene of the Lake Eyre region. Whether or not *patricius* or this referred material in fact represents a distinct Pleistocene form close to *novae-hollandiae* cannot be determined until the Pleistocene fossils are assembled and fully analyzed for variability and significance of differences. At present the validity of *patricius* seems questionable, but it is safe to say that it shows no features that suggest identity with *ocypus*.

The general conclusion to be drawn from the discovery and analysis of *Dromiceius ocypus* is that the structure of the foot of emus of the late Tertiary had already reached the level of specialization seen in the group today. The changes to be noted since then in this group of birds on the mainland have been an increase in size and moderate slenderizing of proportions. The insular emus, if direct descendants, did not change proportions and either became small or represent persistence of a line of small forms.

Family DROMORNITHIDAE

At the Lawson Quarry (locality V 5769) in 1961 a fragment of a pelvis (U. C. Mus. Paleo. No. 60613) was obtained which, although very incomplete, shows features distinctive of the giant Pleistocene bird *Genyornis*. The fragment consists of the base of the left pubis and ischium surrounding the obturator foramen, the posterior and ventral parts of the acetabulum, and the ascending bar of the ischium.

These parts of the pelvis have been compared with those of emus, with photographic plates of *Genyornis newtoni* (Stirling, 1913; pls. XXXVIII and XXXIX), and with a large moa (*Pachyornis elephantopus*). The Pliocene fossil shows (fig. 2) the following features characteristic of *Genyornis* which distinguish it from *Dromiceius*: The pubis at its base, below the obturator foramen, is broader (25 per cent greater) than the ischium rather than the converse (50 per cent less); the ascending bar of the ischium is relatively longer and more slender, and the external surfaces are much more rugose. In these respects the moa is like *Dromiceius* and not *Genyornis*. The fossil from Lake Palankarinna matches *Genyornis* in size rather closely. It differs somewhat in the angle of the ascending bar of the ischium to the axis of the pubis. In *Genyornis newtoni* this is a somewhat obtuse angle posteriorly whereas in the Pliocene bird it is essentially a right angle. The bar also shows greater taper dorsally and some differences in surface configuration. These features may well suggest that a different species is involved but the fragmentary nature of the material affords inadequate basis for naming it as new. The pelvis can be referred with confidence to the genus *Genyornis*, although no comparison is possible with the one other genus of this extinct family, namely *Dromornis*, of which the pelvis is unknown.

This Pliocene fossil has significance in demonstrating that the giant birds of the family Dromornithidae existed as massive specialized ratites in the late Tertiary as well as in the late Pleistocene of Australia and that, in so far as the meagre evidence shows, they have changed little over the considerable time interval involved.

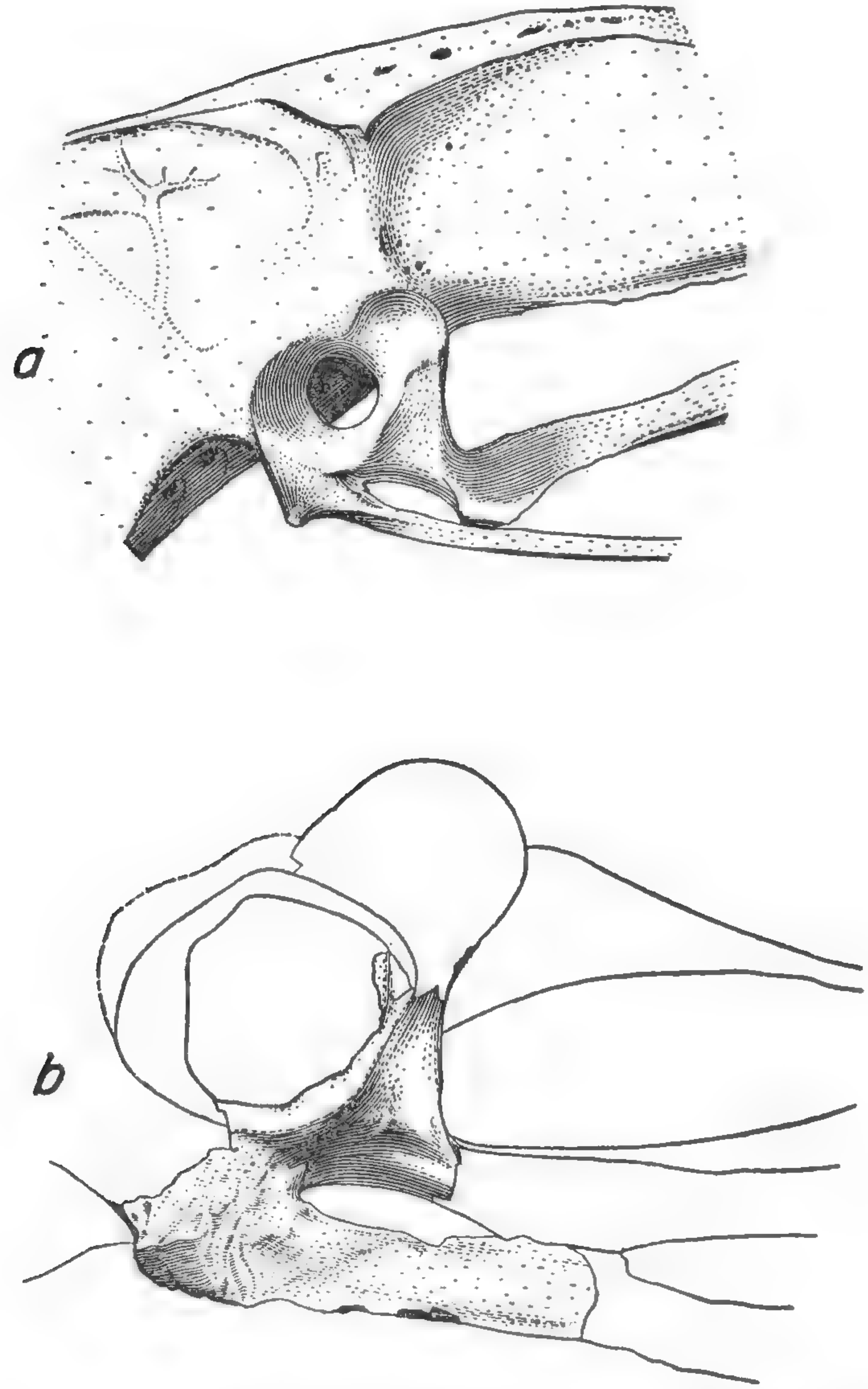

Fig. 2. *a.* Pelvis of *Dromiceius novae-hollandiae*, $\times \frac{2}{5}$. *b.* Fragmentary pelvis of *Genyornis* from Lake Palankarinna, $\times \frac{2}{5}$. Partial reconstruction based on figures of *Genyornis newtoni*.

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A TURTLE SHELL MASK OF TORRES STRAITS TYPE IN THE MACLEAY MUSEUM, UNIVERSITY OF SYDNEY

BY GRAEME L. PRETTY, ASSISTANT CURATOR OF ANTHROPOLOGY, SOUTH AUSTRALIAN MUSEUM

Summary

This paper describes a hitherto unpublished turtle-shell mask of Torres Straits type. Study of the records suggests a provenance of Darnley Island. It is possible that some of its constituent parts may have been re-used from other masks. General features suggest a human face but general form compares with the animal head masks of these islands. The mask is surmounted by a crest of fretted turtle shell plates which bears comparison with feathered head ornaments of Torres Straits. One such ornament, registered No. A40566 in the South Australian Museum collection, is figured and described.

A TURTLE SHELL MASK OF TORRES STRAITS TYPE IN THE MACLEAY MUSEUM, UNIVERSITY OF SYDNEY

By GRAEME L. PRETTY, Assistant Curator of Anthropology, South Australian Museum

Plates 17-18

SUMMARY

This paper describes a hitherto unpublished turtle-shell mask of Torres Straits type. Study of the records suggests a provenance of Darnley Island. It is possible that some of its constituent parts may have been re-used from other masks. General features suggest a human face but general form compares with the animal head masks of these islands. The mask is surmounted by a crest of fretted turtle shell plates which bears comparison with feathered head ornaments of Torres Straits. One such ornament, registered No. A40566 in the South Australian Museum collection, is figured and described.

INTRODUCTION

The Macleay Museum collection came to the University of Sydney in 1889 from the estate of the late Sir William Macleay. Although rich in Macleay's main interest, Natural History, it contained a small but significant collection of Australian and Melanesian ethnology of the period around 1875-1885. Most of it was obtained on his collecting expedition to Torres Straits and New Guinea in 1875, and was added to by collectors in various parts of Australia, Fiji, and the Solomons. It includes a complete mummy from Darnley Island, Torres Straits, a description of which I am preparing for publication.

In past years, the trend of the Museum's major activities has been somewhat at the expense of the ethnological collection. It is now receiving the full attention of the Curator, Miss E. Hahn, who is anxious that its existence should become more widely known.

Although the mask is unlabelled, its general appearance suggests it to be of Torres Straits type (Meyer 1889 plates 1-4). A search of the Macleay Museum papers and correspondence in the Sydney

University archives yielded no references to it. Macleay in his *Journal* of the expedition, recorded ethnological collections from Mokatta, at the mouth of the Katau (now Binaturi) River, Warrior and Darnley Islands in the Straits, and Hall Sound in the Gulf of Papua. Since, of these localities, most time was spent at Darnley, it would seem the most likely provenance for this specimen. Although there are several masks in his collection, Macleay nowhere made specific mention of them. Darnley (Erub) is one of the eastern islands of the Straits.

DESCRIPTION

The mask (plates 17 and 18, fig. 1) has been constructed of plates of turtle shell, which are drilled at the margins, and sewn together with both two strand rolled and three strand plaited vegetable twine 0.2 cm. in width. It is crested by an arch of plates of fretted turtle shell, supported by a central strip of the same material. Beneath and forward, a rod of wood has been lashed to the lower margins. According to Haddon (1912, v. 4, p. 303) this would have been clasped between the teeth by the wearer. It would also have served to strengthen the mask.

The mask measures 37 cm. in length and is 18.5 cm. in width. The total height is 45 cm. Some of the plates of which it is composed show signs of previous use. The holes that have been drilled in them are so placed as to rule out any useful function, *e.g.*, the lashing together of the plates. Presumably they had formed parts of earlier masks. Other plates seem, at some previous time, to have been engraved and lime-filled, though they are now cut down, drilled, lashed and painted over like the rest of the mask. Other holes, *e.g.*, around the margins of the "ears", have clearly been used to tie on tufted and stringed decorations, as may be seen on other masks from the same area and referred to by Linton and Wingert (1946, pp. 124, 127).

Turtle shell has been used to form a well made aquiline nose 10 cm. long. A thin strip, projecting from its tip, has been brought underneath, giving the semblance of a pierced nose.

The pierced ears, quite characteristic of these islanders, have been represented by ovoid plates of turtle shell, 10 cm. long, with the lower halves cut out. These margins, as aforementioned, have been drilled, probably for tufted decoration.

The mask was originally fitted with two artificial eyes of shell nacre, 3.0 x 1.5 cm. One of these has since been lost. A blob of some black resinous substance, perhaps the *isau* or black beeswax mentioned by Haddon (1934, v. 1, p. 325), forms the pupil. The same substance has been used to fill and strengthen the joints between the plates on either side of the eye cavities.

The snout has been furnished with a white painted double row of turtle shell "teeth".

A strip of serrated turtle shell runs along the basal margin, on each side of the mask, probably to represent a beard. From the rod beneath, hangs another fretted and serrated strip of turtle shell of a type, which according to Haddon (1912, v. 4, p. 303) usually represented animal teeth. Probably re-used from a previous mask, it may have been meant to strengthen the impression of a beard, however, it has been attached to the rod with modern European string.

The whole mask, except for the facial parts, has been covered with red ochre. As an upper boundary on the face two bands of white run up from the bridge of the nose, branching out parabolically, each meeting the periphery of the mask at the ear. In a similar fashion a double row of stitching sweeps out from below the tip of the nose, each meeting the white line at the ear. The space in between, including the nose, has been left free of paint.

The crest is made from plates of fretted turtle shell, decorated with white lime-filled engravings. These designs have the zig-zags and banded decoration, adjudged by Haddon (1894, pp. 14-21, 63-66) to be characteristic of the Torres Straits—Kiwai cultures. If taken in conjunction with the bands of white paint sweeping out from the bridge of the nose, the whole bears a strong resemblance to the feathered head ornaments worn in some Torres Straits dances. According to Ray (1907, pp. 137, 140) these were called *dri*, or *d(a)ri*, in the eastern islands. One such ornament, specimen numbered A40566 in the South Australian Museum collection, is illustrated for comparison (pl. 18, fig. 2).

Behind there has been affixed a shell of the egg cowrie, *Amphiperas ovum* Linnaeus 1758. This has been painted red with the rest of the mask. Probably it served as a rattle.

CONCLUSION

In general form this mask compares with the animal head masks once common in the Torres Straits. Nevertheless, the over-riding intention seems to have been to represent features of the human face, perhaps adorned with one of the feathered head ornaments typical of this area.

Haddon (1912, v. 4, p. 302, pl. 34) illustrates a turtle shell mask from Mount Ernest Island (Nagir) where a crocodile head form is surmounted by a human face, fashioned on its upper surface. In the Macleay Museum specimen, the human face is dominant and only the generalized long-snouted animal form remains to point to its possible morphological origins.

ACKNOWLEDGMENTS

Acknowledgment is made, first of all to Miss E. Hahn, Curator of the Macleay Museum, for her many efforts on my behalf. Thanks are offered to Mr. S. Woodward-Smith, Illustration, New Medical School, University of Sydney, for photographs, and to Miss I. Allpress, Librarian of the Linnean Society of New South Wales, and Mr. D. S. Macmillan, Archivist, University of Sydney, for making available documentary material. Mr. N. B. Tindale, Curator of Anthropology, South Australian Museum, and Mr. H. M. Cooper, Hon. Associate in Anthropology, have read the manuscript and made helpful suggestions and comments.

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DESCRIPTION OF PLATES 17 AND 18

PLATE 17.

The mask, full face, showing the features described in the text. Specimen, without registration number, in Macleay Museum, University of Sydney. Scale to be read in centimetres.

PLATE 18.

Fig. 1. The mask, rear view, showing the re-used and engraved plates, the posterior surface of the centrepiece of the crest, and the *Amphiperas ovum* shell affixed behind. Scale to be read in centimetres.

Fig. 2. Head ornament, from Torres Straits (no specific locality). Greatest length 42 cm., greatest width 31 cm. White feathers. Frame coloured blue, vermilion and white. Specimen No. A40566 in South Australian Museum collection. Scale to be read in centimetres.

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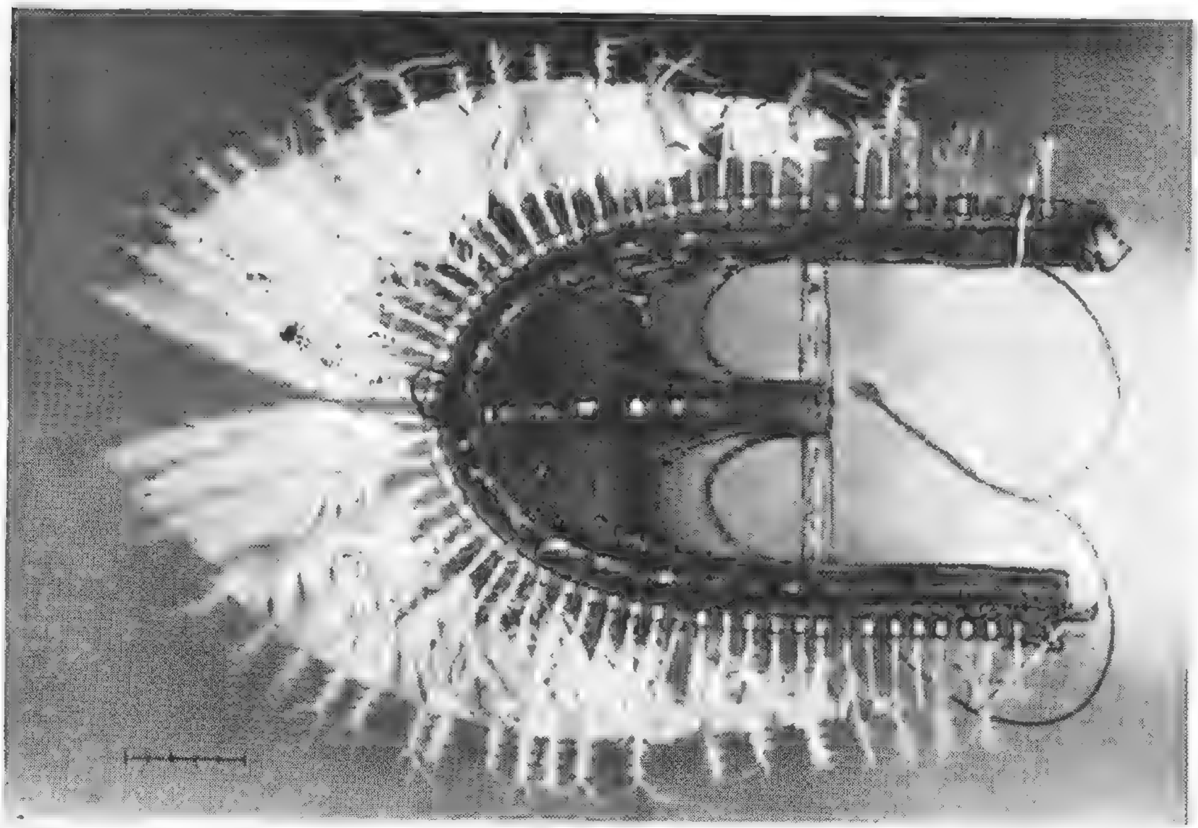

THE AUSTRALIAN RHYPAROCHROMINI (HEMIPTERA: LYGAEIDAE)

BY GORDON F. GROSS, CURATOR OF INSECTS, SOUTH AUSTRALIAN MUSEUM AND G. G. E. SCUDDER, UNIVERSITY OF BRITISH COLUMBIA

Summary

This paper deals with the systematics of the tribe Rhyparochromini (Hemiptera: Lygaeidae) in the Australian region. Twenty species, six of them new, belonging to five genera are described and figured. Most of the species belong to the genus Dieuches; species from this area formerly ascribed to Aphanus are shown all to belong either to Dieuches or to Elasmolomus.

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Plates 19-24

SUMMARY

This paper deals with the systematics of the tribe Rhyparochromini (Hemiptera: Lygaeidae) in the Australian region. Twenty species, six of them new, belonging to five genera are described and figured. Most of the species belong to the genus *Dieuches*; species from this area formerly ascribed to *Aphanus* are shown all to belong either to *Dieuches* or to *Elasmolomus*.

INTRODUCTION

The insects considered in this paper belong to the Lygaeid subfamily Rhyparochrominae, which is characterized by having the suture between sterna IV and V laterally curved anteriorly and not reaching the lateral margin of the abdomen. The tribe Rhyparochromini is distinguished by having the spiracles on abdominal segments III and IV dorsal, whilst all other segments of the abdomen have ventrally placed spiracles: in Scudder (1957) the group is considered as the subtribe Rhyparochromina, but now the taxon is considered to be a full tribe (Scudder 1962b).

Only five genera so far are known to occur in Australia, namely *Bosbequius* Distant, *Dieuches* Dohrn, *Elasmolomus* Stål, *Narbo* Stål and *Poeantius* Stål.

All Australian and Eastern Pacific Island species formerly considered to belong to the tribe Gonianotini and described as species of the genus *Aphanus* Laporte or *Pachymerus* Lepelletier—Serville are shown to belong to the tribe Rhyparochromini and are treated here. This results in the elimination of the Gonianotini in this sub-region. Australian and Eastern Pacific Rhyparochrominae belong only to the tribes Cleradini, Drymini, Lethaeini, Rhyparochromini and

Myodochini in the present arrangement of the tribes. Sweet (personal communication) indicates the imminent erection of some additional tribes but these will not alter the disposition of genera treated in this paper.

KEY TO GENERA OF AUSTRALIAN RHYPAROCHROMINI

1. Lateral margins of pronotum gently convex and corium without a pale subapical spot 2

   Pronotum usually with lateral margins straight or concave; corium with a more or less distinct pale subapical spot 3

2. Lateral carinae to pronotum narrow but distinct; corium brown with irregular ochraceous maculae; scutellum without distinct ochraceous marks apically . . . . . . *Bosbequius* Distant

   Lateral carinae to pronotum broad and expanded in middle; corium ochraceous with irregular brown maculae; scutellum with distinct ochraceous marks apically . . *Elasmolomus* Stål

3. Elongate insects with lateral margins of pronotum lacking a distinct laminate carina; male genital capsule with a small tubercle *Narbo* Stål

   Robust insects, the pronotum with distinct lateral laminate carinae, although sometimes rather narrow 4

4. Basal half of the corium pale, apical half castaneous with a pale subapical spot; pronotal lateral carinae narrow; middle femora in male unarmed; male genital capsule without a small tubercle; membrane if with pale spots then these basal . . . . . *Poeantius* Stål

   Basal half of corium distinctly marked with castaneous; pronotal lateral carinae usually broad and turned slightly dorsal; middle femora in male armed with small spines; male genital capsule with small tubercle; membrane if with pale spot then this apical . . . . *Dieuches* Dohrn

Bosbequius Distant 1903

Bosbequius Distant 1903, Faun. Brit. Ind. Rhynch. 2: 64.

Head triangular, minutely punctate, and with antennal tubercles visible from above; clypeus extending well beyond paraclypeal lobes; antennae with stiff semierect hairs; first segment of antennae extending beyond apex of head, second the longest; rostrum with first segment extending less than half way to base of head.

Pronotum wider than long; disc flat and without distinct transverse impression; lateral margins continued laterally as a laminate carina; lateral margins gently convex; posterior margin slightly concave; disc in anterior half more or less impunctate; lateral and anterior margins and posterior part of pronotum with distinct punctures.

Scutellum longer than wide; basal half of disc slightly excavate; distinctly punctate.

Fore femora incrassate and with small spines more or less along the whole length, terminal ones the most prominent; posterior tarsus with basal tarsomere longer than combined length of the two distal tarsomeres.

Hemelytra without distinct and contrasting dark and pale markings and without a distinct pale subapical spot to corium; clavus with three or more rows of punctures; corium quite densely punctate.

Type species: *Bosbequius latus* Distant 1903, from Tenasserim.

Bosbequius australis Distant 1918

Plate 19, fig. A

Bosbequius australis Distant 1918, Ann. Mag. nat. Hist. (9)2: 260.

Colour. Head brown-black with apex of clypeus slightly ferruginous; antennae pale ferruginous with first segment and apical parts of second and third brown; rostrum ferruginous.

Pronotum with anterior and lateral margins and lateral areas of posterior part, ferrugino-ochraceous; rest of disc ferruginous, with anterior part brown black.

Scutellum brown with apical part slightly ferruginous. Legs brown or dark ferruginous with tibiae and tarsi ferrugino-ochraceous.

Hemelytra ferruginous to dark brown with irregular ochraceous maculae, usually along apical margin of corium and near Cu; membrane fuscous with basal parts of veins and small spots near their apex, somewhat pale.

Venter dark ferruginous.

Structure. Head finely punctate; antennal ratio 7: 22: 17: 20; rostrum reaching between fore and middle coxae.

Pronotal width: Length, 48:34. *Total length*: 7 mm.

Distribution: Queensland, Northern Territory.

Australian records: N.W. Australia, Adelaide River, J. J. Walker (B.M.); Cape York, Coen, 1921-1922, W. McLennan (A.M.).

Dieuches Dohrn 1860

Dieuches Dohrn 1860, Stett. ent. Z. 21: 160.

Dieuches Stål 1872, Ofvers. Vetensk. Akad. Förh., Stockholm, (7): 58.

Dieuches Stål 1874, K. Vetensk. Akad. Handl., 12(1): 161.

Dieuches Scudder, 1962a, Canad. Ent., 94 (7): 766.

Abanus Distant 1909, Ann. Mag. nat. Hist., (8)3: 493.

Maxaphanus Distant 1918, Ann. Mag. nat. Hist., (9)2: 265.

Elongate robust insects; head and much of pronotum fuscous; head triangular with antennal tubercles clearly visible from above; eyes more or less touching anterior margin of pronotum; finely punctate; first antennal segment surpassing apex of head.

Pronotum with lateral margin carinate, the carina laminate, often broad and usually upturned; disc usually with a distinct transverse impression near middle; distinctly punctate; posterior margin slightly concave.

Scutellum usually longer than broad; distinctly punctate; with basal half of disc flat or slightly excavate; often with a vague Y-shaped elevation.

Legs with fore femora moderately swollen and with subapical ventral spines; middle femora in male usually with small ventral spines; tibiae with stout outstanding setae; posterior tarsus with basal tarsomere twice as long as the combined length of the two distal tarsomeres.

Hemelytra distinctly marked with brown or black and ochraceous; usually with a distinct subapical pale spot to corium; membrane if with pale spots, then these apical; clavus with more than three rows of punctures; corium distinctly punctate. Venter fuscous; often with postero-dorsal corner of metapleurae, coxal covers and lateral spots on abdomen, ochraceous. Male genital capsule with a small ventral tubercle.

Type species: *Dieuches syriacus* Dohrn, from Syria and the Mediterranean area.

Dieuches leucoceras (Walker) was recorded from Murray Island by Carpenter (1891): 139, 'one of the specimens from Murray Island seems to me to be identical with Walker's type from Ceylon, in the British Museum,' but it would appear that this record is based on a misidentification; we have seen no specimens of this species from this Island.

KEY TO AUSTRALIAN AND NEW GUINEA SPECIES OF DIEUCHES

1. Large insects; over 10 mm. in length; pronotum conspicuously broad and with a raised central line posteriorly; Banks Island	*grandicus* sp. nov.
Smaller insects, usually under 9 mm. in length, if longer then pronotum not conspicuously broad and with a raised central line posteriorly	2
2. Dorsum and/or legs with long outstanding hairs	3
Insects not hirsute, without long outstanding hairs	4
3. Inner angle of pale subapical spot of corium, truncate	*consanguineus* Distant
Inner angle of pale subapical spot of corium, acute	*hirsutus* sp. nov.
4. Anterior two-thirds of pronotal lateral carinae white and often translucent, if black, then only extreme anterior part so coloured	5
Anterior third to fifth of pronotal lateral carinae, black	11
5. Elongate insects, with legs and antennae appearing long and slender; subapical pale spot of corium constricted in middle	*longicollis* (Dallas)
Insects not greatly elongate; legs and antennae not appearing conspicuously long and slender; subapical pale spot of corium not constricted in middle	6

6. Inner angle of pale subapical spot of corium, truncate . . . . *oceanicus* (Distant)

   Inner angle of pale subapical spot of corium, not truncate 7

7. Pronotum longer than wide, conspicuously constricted laterally and not conspicuously tapering anteriorly; inner angle of corium with a pale triangular spot . . . *torpidus* sp. nov.

   Combination of characters not as above . . 8

8. Pronotum with posterior lobe without pale markings or with a central pale streak and sometimes also one pale spot on each side of streak, near transverse impression 9

   Pronotum with posterior lobe with a central pale streak and two pale spots on each side; anterior margin of corium, seen from side without fuscous spots in basal half; sterna V and VI with pale lateral spots . . . . *finitimus* Van Duzee

9. Anterior margin of corium, seen from side, without fuscous spots in basal half; dorsum of insect chocolate brown . . . . *obscuripes* (Walker)

   Anterior margin of corium, seen from side, with fuscous spots in basal half; dorsum of insects rather black 10

10. Anterior margin of corium, seen from side, with two pale spots in basal half and apically a large pale area coincident with pale subapical spot of corium, and the pale spot laterally on sternum V . . . . *scutellatus* Distant

    Anterior margin of corium, seen from side, with three pale spots in basal half and apically a large pale area coincident with the pale subapical spot of corium, and the pale spot laterally on sternum V . . *enigmaticus* sp. nov.

11. Inner angle of pale subapical spot of corium truncate or acute and continued to inner angle of corium through a fainter and generally more ochraceous spot; pronotal lateral carinae anteriorly rather narrow 12

Inner angle of pale subapical spot of corium not truncate and not continued to inner angle of corium; pronotal lateral carinae not much narrower anteriorly 13

12. Hemelytra reaching almost to apex of abdomen . . . . *notatus* (Dallas)

Hemelytra not reaching almost to end of abdomen, but leaving apical segments of abdomen exposed . . . . *nudus* sp. nov.

13. Terminal segment of antennae completely black . . . . *maculicollis* (Walker)

Terminal segment of antennae with basal part white . . . . *distanti* Bergroth

Dieuches grandicus sp. nov.

Plate 20, fig. A

Head dark ferruginous brown; antennae ferrugino-ochraceous with whole of first segment, apex of second and third, and extreme base and apical half of fourth ferruginous brown; fourth antennal segment with an ochraceous basal annulation; rostrum with first segment ferruginous brown, second and third rather ochraceous and fourth ferruginous with brown apex.

Pronotum with lateral carinae in basal third brown black, in middle ochraceous and in anterior third pale ferruginous; disc dark ferruginous brown to black with pale markings posteriorly consisting of a very short median raised longitudinal line and an ochraceous spot each side situated near transverse impression; anterior margin of pronotum with two vague pale spots.

Scutellum dark ferruginous brown to black with apex slightly pale and with two distinct lateral luteo-ochraceous spots.

Legs ochraceous with coxae and most of femora dark ferruginous brown to black; tibiae fuscous; tarsi more or less ferrugino-ochraceous.

Hemelytra luteo-ochraceous with dark brown to black markings; clavus except for streak and spots at base, and corium except for subapical pale spot and four complete or broken streaks in basal half, dark brown to black; pale subapical spot to corium with inner angle rather obtuse, basal side slightly concave and apical side convex; membrane fuscous, the apex slightly pale.

Abdominal sterna V and VI with lateral pale spots. Insects not hirsute.

Antennal ratio 20: 44: 40: 40; rostrum reaching posterior coxae. Pronotum with broad lateral carinae; lateral margins convergent anteriorly and concave at level of transverse impression of disc; pronotal width: length, 60: 57. Hemelytra reaching apex of abdomen. Fore femora with seven or eight small spines and a single long spine ventrally in anterior row; middle femora of female with four small setigerous spines.

Total length female 10.4 mm.

Type: *Holotype* a female, Moa I., Torres St. (S.A.M.). *Paratypes*: 2 females, Moa, Banks I., Torres St., 18 December 1919, W. McLennan; 1 female, id., 17 December 1919 (A.M.).

A species easily recognized by its size. Only *D. obscuripes* (Walker) is also known from this island and this latter species is only about 7.5 mm. in length, is much narrower and on the posterior part of the pronotum, the pale central line is not conspicuously raised.

Dieuches consanguineus Distant 1904

Plate 21, fig. B

Dieuches consanguineus Distant 1904, Ann. Mag. nat. Hist. (7)13: 268.

Head dark ferruginous brown with clypeus flavescent; antennae ferrugino-ochraceous with apical part of first and third segments slightly fuscous; fourth segment with extreme base and apical $\frac{2}{5}$ dark brown, the rest ochraceous to white; rostrum ferrugino-ochraceous.

Pronotum with lateral carinae, except for extreme posterior corners ochraceous; anterior part of disc dark ferruginous; posterior part of disc ochraceous with punctures, humeral angles and patches each side of mid-line, dark ferruginous. There is a very distinct line of transverse punctures just behind collar and a faint longitudinal keel on both lobes.

Scutellum dark ferruginous brown with apex and two large lateral irregular spots luteo-ochraceous.

Legs ochraceous with coxae and apical parts of femora dark brown; apex of tibiae and tarsi usually fuscous.

Hemelytra ochraceous with dark ferruginous-brown markings; subapical pale spot to corium distinct and with inner angle truncate, basal side concave, apical side convex; basal half of anterior margin of corium, seen from side, completely pale; much of clavus, apical half of corium and corium adjacent to claval suture, castaneous; membrane fuscous with apical pale spot; sterna V, VI and VII with lateral pale spots. Specimens occur which have the darker parts of pronotum, scutellum and hemelytra a deep chocolate with a velvet texture.

Insects distinctly hirsute; dorsum with long upstanding hairs; femora with long outstanding hairs. Antennal ratio 15: 33: 30: 33; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins convergent anteriorly and slightly concave at level of distinct transverse impression of disc. Hemelytra reaching tip of abdomen; fore femora with row of 11-12 short spines; middle femora with three or four short spines in male. Pronotal width: length, 45: 35. Total length 6.2-8.2 mm.

Distribution: Australia.

Australian records: Queensland: Cooktown, 1939 J. L. Erben (Prague); 1 female, Almaden, Chillagoe District N.Q., June-Sept. 1929 W. D. Campbell (A.M.); 1 male, 1 female, Ayr, 25 July 1954 G. Saunders (U.Q.); 1 male, attracted to light, Cairns District A. M. Lea; Birri, Mornington I., 8 May 1960, P. Aitken, N. B. Tindale (S.A.M.); 1 female, Redlynch, 14 Aug. 1938, R. G. Wind (C.A.S.). Torres Straits: 1 male, Prince of Wales I., 21 Feb. 1939, R. G. Wind (C.A.S.). Northern Territory: Daly R. (G. G. E. Scudder, Vancouver); 1 male, Stapleton, G. F. Hill; 1 female, Port Darwin: 3 males, 8 females, 6 nymphs, Darwin Botanic Gardens, 6 Jan. 1961 G. F. Gross; 1 female at light, Mitchell Street, Darwin 5 Jan. 1961. G. F. Gross (S.A.M.); 6, Northern Territory Administration Grounds, Darwin, 21 Sept. 1956 L. D. Crawford; 1, Darwin 8 Oct. 1956 L. D. Crawford (A.N.I.C.).

Similar to *D. oceanicus* (Distant) but dorsum and femora with long outstanding hairs.

Dieuches obscuripes (Walker 1872)

Plate 22, fig. D

Rhyparochromus obscuripes Walker 1872, Cat. Het. B.M. 5: 104.

Rhyparochromus obscuripes Carpenter 1891, Proc. R. Dublin Soc. 1891: 139.

Dieuches obscuripes Distant 1901, Ann. Mag. nat. Hist. (7)8: 509.

Head dark ferruginous; antennae ferrugino-ochraceous with apex of fourth segment dark brown; rostrum ferruginous with tip brown.

Pronotum with lateral carinae ochraceous in middle and with extreme anterior and posterior parts fuscous; disc dark ferruginous with pale markings posteriorly consisting of a short longitudinal median streak and one pale spot on each side near transverse impression.

Scutellum dark ferruginous with apex and two lateral spots ochraceous.

Legs ferruginous brown with base of middle and hind femora ochraceous.

Hemelytra dark ferruginous with a distinct subapical ochraceous spot and in basal half, with anterior margin of corium pale and with three ochraceous spots in transverse series in middle of corium; clavus with a short basal ochraceous streak; subapical pale spot to corium with inner angle acute, basal side more or less straight and apical side slightly concave; basal half of anterior margin of corium, seen from side, without fuscous spots except for extreme base; apical margin of corium dark brown especially in anterior half; extreme apical angle luteous; membrane fuscous with a pale tip.

Abdominal sterna V and VI with lateral ochraceous patches.

Insects not hirsute; antennal ratio 14: 30: 31: 32; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins slightly convergent anteriorly and slightly concave at level of transverse impression; pronotal width: length, 37: 33. Fore femora with nine small and one large spine ventrally in anterior row; middle femora of male with about six small spines basally. Hemelytra reaching tip of abdomen. Total length 7.4 mm.

Distribution: New Guinea, Murray Is., Banks Is.

Australian records: Moa, Banks Is., Torres St., 18 Dec. 1919 W. McLennan (A.M.).

Similar to *D. finitimus* Van Duzee but with posterior part of pronotum with different colouration.

There is an Australian series, many specimens of which approximate the type of *Aphanus oceanicus* Distant, but which are very close in certain details to *obscuripes*. They are very similar in shape and size and the pronotum is on the whole flatter than in the average Australian *Dieuches*. The large apical spot is somewhat truncate along the inner margin in extreme Northern and North Western examples (pl. 23, fig. C) but tends to be more rounded on the interior margin in Central Australian and Western examples (pl. 22, fig. C). In North Eastern examples, this large spot is narrower and very like a New Guinea example of *obscuripes* in the South Australian Museum.

The South Australian Museum specimen from New Guinea and the Banks Island specimens of *obscuripes* both have the basal half of the corium almost devoid of prominent pale markings although a faint pattern appears as a trace and seems to be of the *oceanicus* type. Both specimens of *obscuripes* have only a single pale streak on the clavus along the corial commissure.

These Australian specimens are being provisionally kept distinct as the next species, *Dieuches oceanicus*, but it may be that *oceanicus* is only a subspecies of *obscuripes*. All these specimens have two pale spots on the clavus, the longer along the claval commissure and the shorter along the scutellar margin, and prominent pale markings in the basal half of the clavus.

Dieuches oceanicus (Distant 1901)

Plate 22, fig. C and plate 23, fig. C.

Aphanus oceanicus Distant 1901, Ann. Mag. nat. Hist. (7)8: 502.

Dieuches oceanicus Scudder, 1962a, Canad. Ent., 94(7): 767.

Head dark ferruginous brown; antennae dark ferruginous brown with basal half of second segment ochraceous and fourth segment with a sub-basal whitish annulation; rostrum ferrugino-ochraceous with apex brown.

Pronotum with lateral carinae ochraceous and with extreme posterior part fuscous and extreme anterior slightly ferruginous; disc dark ferruginous brown with pale markings posteriorly consisting of a median longitudinal ochraceous streak and two ochraceous spots on each side near transverse impression.

Scutellum dark brown with an apical and two lateral ochraceous spots.

Legs ochraceous with coxae and apical parts of femora dark brown; posterior tibiae ferruginous brown.

Hemelytra dark ferruginous brown and ochraceous; corium with a distinct pale subapical spot and basal half of corium almost completely pale; clavus with two short basal pale streaks; subapical spot of corium with inner angle truncate; basal side concave and apical side slightly convex; basal half of anterior margin of corium, seen from side without fuscous spots; membrane fuscous with pale apex.

Thoracic venter with coxal covers and posterior margin of metapleurae pale ferruginous; abdominal sterna V, VI and VII with lateral ochraceous patches. Sometimes the colour pattern is more varied than here described with more cream and castaneous colours in place of the usual darker colours.

Insects not hirsute; antennal ratio 12: 27: 27: 28; rostrum reaching middle coxae. Pronotum generally rather flattish and with broad lateral margins convergent anteriorly and more or less straight; disc with distinct transverse impression; pronotal width; length 42: 30.

Fore femora with seven small and one large subapical spine in antero-ventral row. Hemelytra reaching end of abdomen.

Total length: 7.8-8.5 mm.

Distribution: Australian.

Australian records: Northern Territory: Indinda Well, 3 miles west of Andado Stn.; Newcastle Waters, 5 May 1929 T. G. Campbell (A.N.I.C.); Darwin, Jan. 1939 M. Kamper (A.M.); Darwin, 30 Jan. 1914 G. F. Hill; Hermannsburg Capt. S. A. White; Macdonald Downs (S.A. Mus. Exped. Aug. 1930) (S.A.M.); Mt. Olga, Sept. 1948 Bechervaise (N.M.). Queensland: Mt. Isa, Feb. 1954 Lamberts; Coen, 14-27 May 1951 C. Oke (N.M.) Bathurst Head, Jan. 1927 Hale & Tindale; Stewart R., Jan.-Feb. 1927, Hale & Tindale (S.A.M.); Olsen Cave, Rockhampton, Oct. 1924, A. Musgrave; Thargomindah, Apr. 1941 N. Geary; Clermont, Dr. K. K. Spence (A.M.); Torres St.: Prince of Wales Is., 21 Nov. 1939 R. G. Wind (C.A.S.). Western Australia (North): Cossack, J. J. Walker (B.M.); Kimberley Dist., Mjöberg (Stockholm). Western Australia (Central): Nicol Bay District, Clement (G. G. E. Scudder, Vancouver); Tambrey Stn., 24-26 July, 1958 F. J. Mitchell; Pilgangoora near Pilbara, 5 May 1953 N. B. Tindale (S.A.M.); 6, Cocoa Beach, Trimouille Is., Monte Bello Is., 12 Nov. 1953 T. G. Campbell (A.N.I.C.). South Australia: At light, Goyder Lagoon Ruins, 28 July 1957 B. Daily; Fowler Bay (S.A.M.).

Plate 22 fig. C shows a dark example, plate 23 fig. C a chocolate coloured specimen from Darwin.

Dieuches hirsutus sp. nov.

Plate 21, fig. C

Head dark ferruginous brown; antennae dark ferruginous brown (colour of terminal segment unknown); rostrum ferruginous brown.

Pronotum with lateral carinae dark brown anteriorly and posteriorly and ochraceous in centre; disc dark brown to black with pale marks posteriorly consisting of an ochraceous central streak and two pale spots on each side near transverse impression.

Scutellum dark brown to black with apex pale, no pale spots on disc. Legs with base of femora ochraceous; coxae and most of femora dark brown to black; tibiae dark ferruginous and tarsi ferrugino-ochraceous.

Hemelytra ochraceous with dark brown to black markings; clavus dark brown with a pale basal streak; corium dark brown with a pale subapical spot, three basal pale streaks and a pale central spot; subapical pale spot with inner angle acute, basal side concave and apical side convex; membrane dark brown to black with apical third to half pale and with a luteous spot near apical angle of corium and a luteous spot on base of inner curved vein.

Abdominal sterna V and VI with lateral pale spots.

Dorsum and legs with long outstanding hairs; antennal ratio 18: 38: 35: ?; third antennal segment thicker than second and both densely hirsute; rostrum reaching posterior coxae. Pronotum with broad lateral carinae; lateral margins convergent anteriorly and concave at level of transverse impression on disc; pronotal width: length, 47: 42. Fore femora with a long subapical ventral spine.

Total length: Female 10.0 mm.

Type: Holotype female, Northern Territory, Darwin G. F. Hill (S.A.M.).

Paratype: Female, same data (G. G. E. Scudder, Vancouver).

In general appearance similar to *D. finitimus* Van Duzee, but with distinct upstanding hairs on dorsum and on femora.

Dieuches finitimus Van Duzee 1940

Plate 24, fig. A

Dieuches finitimus Van Duzee 1940, Pan-Pacif. Ent. 16: 184.

Dieuches finitimus Scudder 1958, Nat. Hist. Rennell Is., B.S.I. 2: 138.

Head dark ferruginous brown; antennae ferrugino-ochraceous with apical part of first three segments ferruginous; fourth antennal segment with apical half dark brown and basal half luteo-ochraceous; rostrum ferruginous with apex brown.

Pronotum with lateral carinae pale ochraceous with extreme anterior and posterior parts brown to black; disc dark ferruginous brown to black with pale markings on posterior lobe consisting of a central longitudinal ochraceous streak and two ochraceous spots, on each side of streak near transverse impression.

Scutellum dark ferruginous brown to black with apical and two lateral luteo-ochraceous spots.

Legs ochraceous with coxae and apical half of femora dark brown; apical half of fore tibiae and most of middle and hind tibiae dark brown; tarsi ferrugino-ochraceous.

Hemelytra ochraceous with dark brown markings; apical two-thirds of clavus, most of apical half of corium and basal half of corium partially, dark brown; corium with a distinct transversely elongate subapical pale spot, with inner angle somewhat acute, basal side slightly concave and apical side convex; basal half of anterior margin on corium seen from side, without fuscous spots and with apex slightly pale.

Venter with postero-dorsal corner of metapleurae ochraceous; abdominal sterna V, VI and VII with lateral pale spots.

Insects not greatly hirsute; antennal ratio 13: 28: 28: 30; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins convergent anteriorly and more or less straight; disc with a distinct transverse impression; pronotal width: length, 38: 30. Hemelytra almost reaching apex of abdomen.

Total length: 7.4 mm.

Distribution: Solomon Is., New Guinea, New Britain, and Australia.

Australian records: Queensland: Alice River, Mjöberg (Stockholm); 1 male, Horn Is., 2 April 1940 R. G. Wind. Torres St.: 3 males, 1 female, Prince of Wales Is., 3 Nov. 1939 R. G. Wind; 3 males, same data but 23 Nov. 1939 (C.A.S.). The figure is based on a series from Misima Island, Louisiade Archipelago, collected by the Rev. H. K. Bartlett and in the S. A. Museum.

Somewhat similar to *D. obscuripes* (Walker), but with two pale spots on each side of pale median streak on posterior lobe of pronotum, instead of just one on each side, as in *obscuripes*.

Dieuches torpidus sp. nov.

Plate 24, fig. B

Head dark brown with anterior part rather ferruginous; antennae ferruginous with fourth segment basally ochraceous and apically dark brown; rostrum ferrugino-ochraceous with first segment and apical segment dark brown.

Pronotum with lateral carinae ochraceous, narrowly margined with black and posteriorly fuscous; disc dark brown with ferrugino-ochraceous markings posteriorly consisting of a short median longitudinal streak and two spots on each side near transverse impression.

Scutellum dark brown with apex and two obscure lateral spots, ferrugino-ochraceous.

Legs ferruginous brown with base of middle and hind femora and middle and hind trochanters, ochraceous.

Hemelytra dark brown and luteo-ochraceous; corium with a subapical pale L-shaped spot and a C-shaped mark proximally; inner angle of corium with a pale triangular spot; basal half of corium with anterior margin ochraceous and margined with dark brown, with a longitudinal streak and two spots on each side, in middle, and with two or three pale spots along claval suture; clavus with a pale streak along basal party of suture margin and with an obscure ferruginous spot basally; basal half of anterior margin of corium, seen from side, with a median fuscous spot; membrane fuscous and with an obscure basal pale area.

Venter with coxal covers and postero-dorsal corner of metapleurae pale ferruginous; abdominal sterna IV, V, VI with distinct lateral ochraceous patches and sternum VII with indistinct pale spots laterally. Dorsum of insect not hirsute; antennal ratio 20-23: 34-38: 35-37: 35-40, with third segment thicker than fourth and densely covered with short semi-erect hairs; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins not convergent anteriorly, but deeply concave at level of transverse impression on disc; pronotal width: pronotal length, 38-46: 39-43, that is sometimes longer than broad. The longest ratio is 38-43 (in the type), the widest ratio is 46:40; these differences are due to differences in development of the wings. Scutellum with basal half deeply excavate. Fore femora with about eight small spines. Hemelytra with much of basal area and a subapical spot appearing "frosted"; membrane reaching middle of tergum VII but not beyond.

Total length: 8.5 mm.

Type: *Holotype* male, New Guinea, Madang, W. Lohe (S.A.M.). *Allotype* female, Finschhafen, Apkr. 1944 E. S. Ross. *Paratypes*: 2 males, Finschhafen, Apr. 1944; 1 male, 1 female, same loc., 20 Apr. 1944; 2 females, same loc., 21 Apr. 1944; 1 male, same loc., 15 May 1944, all E. S. Ross (C.A.S.).

This species differs from *obscuripes* and all other specimens by the shape of the pronotum and the colour of the hemelytra.

Dieuches scutellatus Distant 1904

Plate 24, fig. C

Dieuches scutellatus Distant 1904, Ann. Mag. nat. Hist. (7)13: 268.

Head black; antennae brown to black with a distinct whitish subbasal annulation to terminal segment; rostrum ferruginous brown with black apex.

Pronotum with lateral carinae ochraceous and with extreme posterior part black and anterior part obscurely fuscous; disc black with ferrugino-ochraceous markings posteriorly consisting of a short median longitudinal streak and one spot on each side near transverse impression.

Scutellum black with apex ochraceous and with two lateral ferrugino-ochraceous spots.

Legs brown to black with basal part of middle and hind femora ochraceous.

Hemelytra ochraceous and dark brown to black; corium with a distinct subapical pale spot and in basal half with two pale spots on anterior margin and two pale spots near claval suture; clavus with two short pale streaks; subapical pale spot of corium with inner angle somewhat acute and with both basal and apical margins convex; basal half of anterior margin of corium, seen from side, with a median fuscous spot and base black; membrane fuscous with a pale apex.

Venter with postero-dorsal corner of metapleurae ochraceous; abdominal sternum V with distinct lateral ochraceous patch and sternum VI sometimes with an obscure ferrugino-ochraceous small spot laterally.

Insects not hirsute; antennal ratio 11: 25: 25: 28; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins convergent anteriorly and concave at level with transverse impression of disc; pronotal width: pronotal length, 42: 32. Fore femora with four or five short spines in anterior row. Hemelytra just reaching apex of abdomen.

Total length: 7.3 mm.

Distribution: Australian and possibly New Guinea.

Australian records: North-western Australia:—Derby, Kimberley District and Noonkanbah, Mjöberg (Stockholm); Flora Valley Stn., 12 Oct. 1953 N. B. Tindale (G. G. E. Scudder, Vancouver). Onslow, Nov. 1955 E. T. Smith; North-west Australia, from C. French Jn. Collection (N.M.). Central Western Australia: 3, Pilgangoora, 5, 6 & 9 May 1953 N. B. Tindale; Tambrey, 24-26 July 1958, F. J. Mitchell (S.A.M.) Tambrey Stn., 28 July 1958 R. P. McMillan (W.A.M.). Northern Territory: 2, Katherine, 26 Sept. 1953, G. F. Gross; 2, Tennants Ck. J. K. Field; Finke R., MacDonnell Ranges, Capt. S. A. White; Macdonald Downs, S.A. Museum Exped. Aug. 1930; Haast Bluff Stn., 2,000 feet, 62° F., at mercury vapour light, N. B. Tindale (S.A.M.). Queensland: Laura and Alice River, Mjöberg (Stockholm). Townsville Distr. (S.A.M.); 2, Almaden, Chillagoe, 10 Oct. & Oct.-Nov. 1927, W. D. Campbell (A.M.). South Australia: Madigan Gulf, L. Eyre, 5 Nov. 1955, at light, E. T. Giles (G. G. E. Scudder, Vancouver).

Similar to *D. distanti* Bergroth, but with anterior part of lateral pronotal carinae pale instead of broadly black anteriorly. A very variable species; the hind lobe disc of the pronotum is generally black or concolorous with the disc of the fore lobe. However examples occur with the fore lobe black on the disc and the hind lobe chocolate. Several examples also have three colours on the corium, black or deep brown, ochraceous and luteous; such an example is figured.

Dieuches enigmaticus sp. nov.

Plate 21, fig. D

Head brown-black; antennae ferrugino-ochraceous with apical part of segments fuscous, the fourth segment quite brown with a basal pale annulation; rostrum with basal segment brown, other segments ferrugino-ochraceous.

Pronotum with lateral carinae pale except for extreme posterior corner; disc brown-black with three spots posteriorly near transverse impression.

Scutellum brown-black with an apical and two lateral pale spots.

Legs ochraceous with apical part brown-black and with a distinct pale subapical spot; subapical spot to corium with inner angle rather obtuse and sides convex; basal half on anterior margin of corium seen from side, with three or four fuscous spots; membrane fuscous with tip pale.

Abdominal sterna V and VI with lateral pale spots. Fore femora and midfemora in male with a row of short spines beneath, hind femora with several fine spines.

Anterior lobe of pronotum, scutellum, and a long patch on head between eyes, finely punctate.

Total length: 7-8 mm.

Type: Northern Australia, Marrakai Stn., 28-31 July 1929 I. M. Mackeras & T. G. Campbell (A.N.I.C.). *Paratypes*: 1 female, Western Australia, Wyndham, 4 Oct. 1929 T. G. Campbell; 1 female, Western Australia, Wyndham, 16-28 Feb. 1931 H. J. Willings; 1 male, Monte Bello Is., Trimouille Is., Cocoa Beach, 10 Nov. 1953 T. G. Campbell (A.N.I.C.).

Similar to *D. scutellatus* Distant, but slightly smaller and with basal half of anterior margin of corium, seen from side, with more than a single fuscous spot.

Dieuches distanti Bergroth 1916

Plate 22, fig. B

Dieuches distanti Bergroth 1916, Proc. Roy. Soc. Vict. (n.s.) 29: 10.

Head dark brown to black; antennae dark ferruginous to brown, the fourth segment with a basal pale annulation; rostrum ferruginous-ochraceous with apex brown.

Pronotum with lateral carinae pale only in middle; disc dark brown to black, the posterior part with a short median pale longitudinal streak and usually one pale spot on each side.

Scutellum dark brown to black; sometimes with apical and lateral pale spots.

Legs ochraceous with coxae and apical part of femora dark brown to black; tibiae fuscous; apex of tarsi brown.

Hemelytra ochraceous with apical half of clavus and corium dark brown to black, the latter with a distinct pale subapical spot; subapical pale spot of corium with inner angle obtuse, and with both basal and apical sides convex; basal half of anterior margin of corium, seen in side view, with a single fuscous spot; membrane fuscous with an apical pale spot.

Abdominal sterna V and VI with lateral pale spots.

Insects not distinctly hirsute; antennal ratio 14: 30: 32: 33; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins convergent anteriorly and more or less straight; disc with transverse impression; pronotal width: length, 43: 32. Fore femora with seven to nine short spines in anterior row; middle femora in male with six or seven spines, the basal four longer than apical ones. Hemelytra just reaching tip of abdomen.

Distribution: Northern Australia.

Australian records: Western Australia:—Pilgangoora Well, 8 June 1953 N. B. Tindale (G. G. E. Scudder, Vancouver). Pilgangoora, 5 Apr. 1953 N. B. Tindale; Meekathara-Billiluna Pool, Canning Stock Route Expedition, Apr. 1930-Aug. 1931 (S.A.M.). Northern Territory: Areyonga, 1958 A. G. Woolcock; Finke Crossing, 1933, J. W. Rose (S.A.M.). Queensland: Mt. Isa, Jan. 1954 Lamberts (N.M.); Clermont, Dr. K. K. Spence (A.M.).

In general appearance similar to *D. oceanicus* (Distant) but with anterior part of pronotal carinae distinctly and broadly fuscous instead of white.

Dieuches maculicollis (Walker 1872)

Plate 22, fig. A

Rhyparochromus maculicollis Walker 1872, Cat. Het. B.M. 5: 111.

Dieuches atricornis Stål 1874, K. svenska. Vetensk. Akad. Handl. 12(1): 161.

Dieuches maculicollis Distant 1901, Ann. Mag. nat. Hist. (7)8: 508.

Dieuches maculicollis Scudder 1962a, Canad. Ent., 94(7): 767.

Head, rostrum and antennae, including fourth antennal segment, dark brown to black.

Pronotum with lateral carinae dark brown to black on anterior and posterior thirds and ochraceous in middle; disc dark brown to black with posterior pale markings consisting of a short median longitudinal streak and two ochraceous spots on each side near transverse impression.

Scutellum dark brown to black with apical angle ochraceous and with two lateral pale spots.

Legs dark brown to black with base of femora and trochanters of second and third pairs of legs only ochraceous.

Hemelytra ochraceous and dark brown or black; clavus dark with a basal pale streak; corium with a subapical pale spot and basal half with anterior margin pale and with four or five pale spots; subapical pale spot of corium with inner angle more or less acute and basal and apical sides convex; basal half of anterior margin of corium, seen from side, without fuscous spots; membrane opaque yellowish with basal and apical margins broadly dark brown.

Venter with postero-dorsal corner of metapleurae ochraceous; abdominal sternum V laterally with distinct ochraceous spot and sternum VI laterally with obscure small ferruginous spots.

Insects not hirsute; antennal ratio 12: 25: 27: 30; rostrum reaching middle coxae. Pronotum with broad lateral carinae; lateral margins hardly convergent anteriorly and more or less straight; pronotal width: length 33: 29; disc with distinct transverse impression and with anterior lobe distinctly convex. Fore femora with five or six small spines and one or two large subapical spines. Hemelytra almost reaching apex of abdomen.

Total length: 6.6 mm.

Distribution: Australia.

Australian records: Queensland:—1 female, Nangram Lagoon, 12 m. E & 3 m. N of Condamine, 16 Aug. 1954 R. A. Stirton (C.A.S.); 2 males, Somerset Dam, 24 Oct. 1953 T.E.W.; Deception Bay, 25 March 1954 Y. P. Beri; Brisbane, Feb. 1954 N. J. Thompson (U.Q.); Cunnamulla, 1, 17 Dec. 1940, 2, Oct. 1941, 1, Nov. 1941 N. Geary (A.M.). New South Wales: Sydney, Apr. 1931 K. K. Spence; Como, Dec. 1951 J. Freeman (A.M.). Australian Capital Territory: Molongolo, 4 Apr. 1930 L. Graham (A.N.I.C.). Victoria: Mildura, Feb. 1955 C. Flynn (U.Q.), 5, Kerang, 28-30 Apr. 1946 R.E.T.; Redcliffs, presented 18 Apr. 1925 A. S. Cudmill (N.M.). South Australia: Adelaide distr., Mar. 1920 W. E. Hodson; Prospect, 5 Aug. 1954 G. F. Gross (G. G. E. Scudder, Vancouver); 2, same data; Prospect, 22 Mar. 1952 G. F. Gross; Prospect, 6 Sept. 1952 G. F. Gross; 7, Highgate, 23 July 1959 E. C. Lindsay; Wild Horse Plains 10-16 Apr. 1956 C. J. Martin; Upper Arcoona Ck., Gammon Ranges, 16 Sept. 1956 G. F. Gross; Italowie Gorge, 30 Oct. 1955 E. T. Giles; no locality Mar. 1921 (S.A.M.). At roots of vine, Barossa Valley, 2 Apr. 1949 (W.A.R.I.).

A species easily recognized by the completely black terminal segment to the antennae and black bases of the fore femora.

Dieuches notatus (Dallas 1852)

Plate 23, fig. A

Rhyparochromus notatus Dallas 1852, List. Hem. B.M. 2: 569.

Dieuches notatus Stål 1874, K. svenska Vetensk. Akad. Handl. 12(1): 161.

Head dark brown to black with two small ferruginous spots on vertex on level with anterior margin of eyes; antennae dark brown to black with a basal ochraceous annulation to fourth segment; rostrum ferruginous to dark brown.

Pronotum with lateral margin dark brown to black in anterior and posterior thirds and ochraceous in middle; disc on anterior half black; posterior half of disc ochraceous with fuscous punctures, with humeral angles black and with four longitudinal fuscous streaks.

Scutellum black with apex ochraceous and with two lateral ferrugino-ochraceous spots.

Legs ochraceous with coxae and most of femora dark brown to black; fore and middle tibiae with apex and base fuscous, the hind tibiae more or less completely ferruginous to dark brown; tarsi with apical part of tarsomeres fuscous, the posterior tarsi almost completely dark ferruginous.

Hemelytra ochraceous with ferruginous and dark brown to black markings; clavus with punctures and irregular intervening areas ferruginous, the extreme base black; corium with a distinct pale subapical spot, apical margins and an almost complete transverse band, black; basal half of corium with punctures and streaks dark ferruginous brown; subapical pale spot to corium if continued to inner angle of corium then with inner angle of spot acute, if not continued to inner angle of corium then with inner angle of spot truncate; basal margin of spot slightly concave, the apical margin straight; basal half of anterior margin of corium, seen from side, without fuscous spots; membrane completely fuscous.

Abdominal sterna V, VI, and VII with lateral pale spots.

Insects not hirsute; antennal ratio 15: 27: 27: 34; rostrum reaching middle coxae. Pronotum with lateral carinae very narrow towards anterior; lateral margins strongly convergent anteriorly and slightly concave at level of transverse impression of disc; pronotal width: length 38: 33. Fore femora with about six small and one large ventral spine. Hemelytra almost but not quite reaching apex of abdomen.

Total length: 6.9-8 mm.

Distribution: Australia, Tasmania, Lord Howe Island, and New Zealand.

Australian records: Queensland:—13, Brisbane, Mar. 1957 J. H. Martin; same loc., 10 Feb. 1951 M. Carpenter; same loc., 8 June 1951 J. Denmead; same loc., Aug. 1955 N. J. Thompson; same loc., 3 Mar. 1956 S. Sekon; Lawes, 20 Feb. 1956 W. F. William; Tambo, 16 Aug. 1955 B. R. Grant; Mbore, Jan. 1951 Lipsett; Beaudesert, 5 Jan. 1954 R. E. Harrison; Stanthorpe, 1 June 1956 J. Bonner (U.Q.); same loc.; Dalby, Mrs. F. H. Hobbler; Mt. Tambourine, A. M. Lea; Cunnamulla, H. Hardcastle (S.A.M.); same loc., Oct. 1941 N. Geary; Miles, 10 Jan. 1939 N. Geary; Olsen's Caves, Rockhampton, Oct. 1924 A. Musgrave; Rockhampton, Oct, 1926 A. Musgrave; Warwick, Sept. 1947 Mrs. Miller, (A.M.) 1 male, 5 females, Roma, 5 Aug. 1954 R. A. Stirton; 1 male, Taloona Stn., 48 miles north of Roma, 6 Aug. 1954 R. A. Stirton (C.A.S.). New South Wales: Canowindra 7 Jan. 1955 F. E. Wilson (S.A.M.) Caldwell, 30 Dec. 1951, V. Robb; Deniliquin, 1914 B. Reeves (N.M.) 5, Bombala, 4 Mar. 1931 Rev. A. J. Barret; Bogan River, Sept. 1931 J. Armstrong; same loc. & collector, no date; Nyngan 7 Apr. 1931 J. Armstrong; Hornsby, G. Gibbons; Sydney, 24 May 1925 W. W. Froggatt (A.M.); Sydney, ridge between Mossman's Bay and Middle Harbour J. Langhans (G. G. E. Scudder, Vancouver); 4, Gunnedah, 23 Aug. 1950 A. Dyce; 2, Pilliga, 1925 W. W. Froggatt; 5, Forbes, 20 May 1925 and 24 May 1925 W. W. Froggatt; Tweed R., 17 July 1904 W. W. Froggatt; Coolibah, 20 Oct 1905 W. W. Froggatt; nr. Bourke, 26 Oct. 1949 S. J. Paramanov (A.N.I.C.). Australian Capital Territory: 3, Canberra, Jan. & May 1930 J. Evans (A.N.I.C.). Victoria: Bamawn, W. F. Hill (S.A.M.) 10, Studley Park, 2 Aug. 1923 J. E. Dixon; 3, Kerang, 2 May, 25 Aug., 3 Oct. 1946 R. E. Tillyard; Redcliffs, 18 June 1925 A. S. Cudmore; Fern Tree Gully, J. E. Dixon; loc.?; (N.M.) Melbourne (Stockholm). Tasmania: 3 (one a nymph), E. point of Babel I., 16 Mar. 1960 T. G. Campbell (A.N.I.C.); Launceston (S.A.M.). South Australia: 2, Whyalla, 16 & 23 Aug. 1947 D.S. (N.M.); Underdale, 18 Jan. 1959 G. F. Gross (G. G. E. Scudder, Vancouver); 2, same loc & collector, 1 & 21 Jan. 1959; Fulham Gardens, Jan. 1959 G. F. Gross; "Kurlge", Blackwood, 850ft., at mercury vapour light, 84° F., 27 Feb. 1957 N. B. Tindale; Blackwood, 13 Dec. 1959 M. Kenny; Mylor, 5 May 1948 G. F. Gross; 2, Coomandook, 4 June 1948 G. F. Gross; 2, Maitland, E. R. Waite; Curramulka, 3 Dec. 1954, G. F. Gross; Kielpa, Aug. 1958, P. W. Greenfield; Nth. End, Pt. Lincoln, 20 Nov. 1957 M. Garrick (S.A.M.). Western Australia: 2, Warren River, W. D. Dodd (S.A.M.); Lord Howe I., 2, A. M. Lea (S.A.M.).

The species is also represented by a series of six specimens from New Zealand collected amongst litter on the ground at P.D.P. Owairaka, Auckland, 19 May 1960 Mrs. B. M. May (Plant Diseases Division, D.S.I.R.).

A distinct species recognized by the slightly brachypterous condition, the very narrow pronotal carinae, usually pale truncate inner angle to spot on corium subapically, and the two ferruginous spots on vertex.

Dieuches nudus sp. nov.

Plate 23, fig. B

Similar to *D. notatus* (Dallas) but with head lacking the pale spots; with a narrower pale annulation to fourth antennal segment; with antennal ratio 18: 35: 32: 38; pronotal lateral carinae broad anteriorly and not distinctly narrowed; lateral margins of pronotum not distinctly convergent anteriorly and more or less straight; posterior half of pronotal disc more or less completely pale and without fuscous markings except on humeral angles; corium without distinct fuscous markings except in apical half; inner angle of subapical pale spot to corium always truncate; hemelytra reaching only onto tergum VI and not beyond; fore femora in both sexes with two prominent spines, one near apex, and a series of smaller spines. Venter with coxal covers and posterior margin of metapleurae pale.

Total length: Male 7.7 mm., female 8.5 mm.

Loc. *Holotype* male, Whittata, Andamooka Ranges, South Australia, 22 Aug. 1948 G. F. Gross (S.A.M.). *Allotype* female, Whyalla, South Australia, 7 Sept. 1947 D.S. (N.M.). *Paratypes*: South Australia:—2 females, Whittata, Andamooka Ranges, 20 Aug. 1948 G. F. Gross; 1 female, same loc., 22 Aug. 1948 G. F. Gross; 1 male, Andamooka Ranges, Aug.-Sept. 1948 G. F. Gross; Leigh Ck., (S.A.M.) 4 males, 3 females, Ooldea, July 1921 J. A. Kershaw (N.M.) 1 male, 2 females, same data (G. G. E. Scudder, Vancouver). Victoria: 1 male, 2 females, Kewell, Nov. 1892 (N.M.). Western Australia: 2 males, Clampton 46—1922 & 1923 (W.A.M.). Northern Territory: Double Punch Bowl, Henbury, 15 Oct. 1953 G. F. Gross (S.A.M.).

Dieuches longicollis (Dallas 1852) comb. nov.

Rhyparochromus longicollis Dallas 1852, List. Hem. B.M. 2: 570.

Plate 19, figs. B, C

The badly damaged type of this species is said to come from Australia but we have seen no other specimens from here. In the Paris Museum is a female specimen purported to be the same species from Sumatra (Padang), and in the South Australian Museum is a male from Timor which appears to have the necessary characteristics of the species, but is at first sight rather different in appearance to the Sumatran specimen.

A close comparison of the basic elements of the colour pattern of the Sumatran and the Timor examples suggests that the two may be the same species. A comparison of various dimensions in comparison to one measurement (the total length) adjusted to the same value (1,000) gives a close correlation, except that the Timor example has a much shorter rostrum; we are of the opinion that these are the same species. Mr. R. Izzard of the British Museum kindly supplied a similar set of measurements from the head and thorax of the type (all that remains) in the British Museum. These measurements do not agree as closely, especially in that the thorax is longer than wide, whereas in the other two it is wider than long. Nevertheless as the one species appears to occur with fair differences from opposite ends of the Indonesian Archipelago it seems reasonable that an Australian race of the same species would be more divergent. The Sumatran and Timor examples are therefore considered to be probably races of the Australian *longicollis* and both are figured (Timor plate 19 fig. B; Sumatra plate 19 fig. C).

The actual measurements considered in the comparison were:—

Example Measurement	*Sumatra*	*Timor*	*Type* (Australis)
Length Antennal Segment I	1·30mm.	1·01mm.	missing
Length Antennal Segment II	2·38mm.	1·63mm.	missing
Length Antennal Segment III	2·19mm.	1·63mm.	missing
Length Antennal Segment IV	missing	2·38mm.	missing
Length Rostral Segment I	1·23mm.	0·63mm.	1·40mm.
Length Rostral Segment II	1·31mm.	0·81mm.	1·87mm.
Length Rostral Segment III	1·19mm.	0·69mm.	2·13mm.
Length Rostral Segment IV	0·63mm.	0·34mm.	
Length of head	1·30mm.	1·16mm.	1·73mm.
Width of head across eyes	1·30mm.	1·19mm.	1·60mm.
Length of Pronotum	1·88mm.	1·63mm.	2·93mm.
Width of Pronotum	2·25mm.	1·84mm.	2·80mm.
Total Length	9·18mm.	7·86mm.	app. 10·5mm. (Calc. from Dallas' cited length)

The adjusted measurements for closer comparison are:—

Example Factor	*Sumatra* Eyepiece Divisions ×0·734	*Timor* Eyepiece Divisions ×0·63	*Type* Izzard's Eyepiece Divisions ×1·05
Measurement			
Length Antennal Segment I	142	129	missing
Length Antennal Segment II	260	230	missing
Length Antennal Segment III ...	240	230	missing
Length Antennal Segment IV....	missing	302	missing
Length Rostral Segment I.......	132	90*	133
Length Rostral Segment II	143	103*	178
Length Rostral Segment III	128	87*	203
Length Rostral Segment IV	68	41*	
Length of head	142	148	165
Width of head across eyes	142	150	152
Length of pronotum	202	206	279*
Width of pronotum	243	233	269*
Total Length	1,000	1,000	1,000

Measurements which are noticeably divergent from the other two are marked *.

The description of the species given here is based on the Sumatran and Timor examples.

Head black; antennae black with an ochraceous sub-basal annulation to fourth segment; rostrum brown to black with second segment ochraceous.

Pronotum with lateral carinae ochraceous; disc black with two luteous spots on anterior margin or absent (Timor example) and posterior part with luteous or ochraceous markings consisting of a pale spot on transverse impression laterally, a median longitudinal narrow streak and a pale streak on each side, sometimes divided into anterior and posterior spots.

Scutellum black with apex luteous and with two lateral luteous or ferrugino-ochraceous spots.

Legs ferrugino-ochraceous with base of femora and trochanters ochraceous; apical part of femora dark brown to black; base and apex of tibiae fuscous.

Hemelytra ochraceous and dark brown to black; clavus fuscous with scutellar and commissure margins narrowly pale and with a pale streak emitted from base; corium with most of anterior margin pale and with a pale subapical spot, the latter constricted in middle; base of corium with a long streak and a spot near claval suture, the streak often incomplete; another streak between this and the luteous exterior margin with a spot on either side behind level of apex of scutellum, the outer spot continuous with the pale costal margin. Membrane fuscous and without a pale apical spot.

Venter with lateral parts of sterna V to VII predominantly and narrowly pale.

Dorsum of insect non-hirsute; elongate insect with relatively long legs and antennae; rostrum reaching to or almost to hind coxae. Pronotum appearing rather elongate, lateral carinae broad and distinct; lateral margins convergent anteriorly and slightly concave; disc with distinct transverse impression behind middle. Fore femora (female) with about eight small and a large subapical spine ventrally in anterior row; middle femora with five or six small spines. Hemelytra reaching to, but not beyond middle of tergum VII.

Total length: 7.9-10.5 mm.

Distribution: Sumatra, Timor and Australia.

Specimens seen: 1 female Sumatra, Padang (Paris Museum); 1 male Uato Lari, Portuguese Timor, 19 May 1959 I. B. Freytag (S.A.M.).

This species is easily recognized by relatively long legs, antennae and general appearance and by the constricted pale subapical spot to the corium. The species is rather similar to *Narbo biplagiatus* (Walker), but may be distinguished by having distinct laminate lateral carinae to the pronotum.

Elasmolomus Stål 1872

Elasmolomus Stål 1872, Öfvers. Vetensk. Akad. Förh. 1872 (7) : 58.

Elasmolomus Stål 1874, K. svenska Vetensk. Akad. Handl. 12(1) : 160.

Aphanus Barber 1958 (*nec* LaPorte), Insects of Micronesia 7(4) : 215.

Elongate oval insects; head triangular with antennal tubercles visible from above; eyes more or less in contact with anterior margin of pronotum; finely punctate; antennae with first segment exceeding apex of head.

Pronotum wider than long with anterior half of disc dark brown or black and posterior half pale with fuscous punctures; disc sometimes with a median transverse impression, but lateral margin of pronotum with a distinct laminate carina and gently convex throughout; posterior margin slightly concave; distinctly punctate with punctures on anterior half of disc smaller than those on posterior part.

Scutellum longer than wide; dark brown with an apical V-shaped pale mark; distinctly punctate; basal half of disc shallowly excavate.

Legs with fore femora moderately swollen and with a few small ventral well spaced spines; tibiae with distinct outstanding stout setae; posterior tasi with basal tarsomere more than twice combined length of the two distal tarsomeres.

Hemelytra pale with brown mottling and punctures, the anterior margin with a distinct fuscous bar in apical half and with apical angle fuscous; clavus with more than three rows of punctures; corium rather densely punctate; apex of membrane just reaching or almost reaching tip of abdomen.

Venter dark brown with coxal covers and postero-dorsal corner of metapleurae pale; sterna laterally usually with pale spots.

Type species: *Cimex sordidus* Fabricius 1787.

Key to Australian species of *Elasmolomus*.

1. Over 6.5 mm.; pronotal disc with distinct transverse impression	*sordidus* (Fab.)
Under 6.5 mm.; pronotal disc without a distinct transverse impression	2
2. General colour brown or ferruginous, 6-6.5 mm. long	*papuanus* (Dist.)
General colour black, 5.5-6 mm. long	*v-album* (Stål)

Elasmolomus sordidus (Fab. 1787)

Plate 21, fig. A

Cimex sordidus Fabricius 1787, Mant. 2: 302.

Lygaeus sordidus Fabricius 1794, Ent. Syst. 4: 164.

Lygaeus sordidus Fabricius 1803, Syst. Rhynch.: 231.

Rhyparochromus sordidus Dallas 1852, List. Hem. B.M. 2: 566.

Beosus sordidus Stål 1868, Hem. Fabr. 1: 78.

Pachymerus (*Elasmolomus*) *sordidus* Stål 1874, K. Vet. Akad. Handl. 12(1): 161.

Aphanus sordidus Distant 1903, Faun. Brit. Ind. Rhynch. 2: 79.

Aphanus littoralis Distant 1918, Ann. Mag. nat. Hist. (9)2: 262.

Aphanus sordidus Hoffmann 1932, Lingnan J. Sci. 11(1): 130.

Aphanus littoralis Corby 1947, Bull. ent. Res. 37: 611.

Aphanus littoralis Lindberg 1958, Comment. biol. Helsingf. 19(1): 66.
Aphanus sordidus Barber 1958, Insects of Micronesia 7(4): 216.

Head dark brown; antennae ochraceous with a few spots at apex of first segment, apical parts of second and third, and apical half of fourth, dark brown; rostrum ferrugino-ochraceous with apex dark brown.

Pronotum ochraceous with anterior half of disc and punctures, dark brown; lateral carinae and posterior part of pronotum ochraceous, the extreme posterior part of carinae fuscous, and the anterior part of carinae also sometimes fuscous.

Scutellum dark brown with apical half with a more or less distinct broad ochraceous V-shaped area and with fuscous punctures.

Legs ochraceous with apical half to third with two fuscous annulations, these sometimes united; apex of tibiae and tarsi frequently fuscous. Hemelytra, like posterior part of pronotum, ochraceous with fuscous punctures and with odd and irregular brown maculae; membrane with brownish maculae and with tip rather pale.

Antennal ratio 15: 31: 30: 31; rostrum reaching middle coxae. Fore femora ventrally with an anterior and posterior row of five or six small spines; fore tibiae of male with two small blunt projections on apical half. Pronotal width: length, 50: 38; disc of pronotum with a distinct transverse impression.

Total length: 7.7-9.2 mm.

Distribution: Throughout the tropical regions of the Eastern Hemisphere. Specimens seen from Cape Verde Is., Senegal, Guinea, Rodriquez Is., Nigeria, Blue Nile, Sudan, Tanganyika, S. India, Indo-China, Laos, Bengal, Burma, Assam, Ceylon, Hong Kong, China, Malay Archipelago, Philippine Is., Okinawa, S. Mariana Is., Sumatra, Moluccas, N. Australia.

Australian records: Northern Territory:—13, C.S.I.R.O. Experimental Station, Katherine, Mar. 1951 W. Arndt; 2, Katherine, 18 Apr. 1956 L. D. Crawford; 4, Berrimah, N.T., 30 Aug. 1956 L. D. Crawford; 1, N.T.A. grounds, Darwin, 29 Sept. 1956 L. D. Crawford (A.N.I.C.); Darwin Botanic Gdns., 6 Jan. 1961 G. F. Gross (S.A.M.). The Waite Agricultural Research Institute in Adelaide is now maintaining an experimental colony of this species originating from a series from Katherine, N.T., taken 16 July 1960, collected by P. W. M.

Our friend and colleague Mr. L. D. Crawford kindly passed on the following notes and extracts from index cards on the habits of this bug kept while working as an entomologist with the Northern Territory Administration. We quote—

"PEANUT TRASH BUGS". From Annual Report—Entomologist, N.T.A., 1 July 1955-30 June 1956.

"This local species is universally present wherever peanuts and other oil crops are grown and stored on Northern Territory farms, and it is quite obvious that, left unchecked, as is usually the case, they cause serious losses in oil content, and adversely affect the germination. These bugs are able to extract all the oil out of unshelled peanuts, and have also been observed feeding on sunflower seeds and even sorghum grain. It would seem that the use of control measures should be considered for all oil crops, as these bugs appear to be equally at home out in the field under plants or in storage sheds, where they feed on the bagged peanuts at night time.

"Gammexane dust has been found to control them, but, owing to the risk of tainting, lindane dust would be preferable. The bugs have also been observed in and under matured but unpicked lettuces and Chinese cabbage at the Berrimah Farm. Lygaeid bugs (*Aphanus* spp.) with similar habits have been observed from Nigeria, where they cause poor germination, loss of oil content, and make the remaining oil in the peanuts rancid".

From Monthly Report, April 1956. (Visit to Katherine.)

"*Peanut Storage.* A number of bags of peanuts kept in the one place for two years in a shed at the N.T.A. Farm were crawling with peanut trash bugs, which were also present on the walls of the shed and the surrounding grass. Most of the peanuts were soft and spongy, being devoid of oil. At night the bugs were observed feeding on unshelled peanuts, and even on sorghum grain. As this pest is common wherever peanuts are harvested and stored, it would appear that it is of considerable importance, and control measures are therefore justified on all peanut farms. It was reported later that a dusting with 4 per cent Gammexane dust had given an adequate control of the bugs at the N.T.A. Farm."

Extracts from index cards kept while working as Entomologist, N.T.A., Darwin.

PEANUTS, STORAGE.

"Aug. 1955. Bill Alexander, Daily River farmer, reported that the black peanut trash bugs were in swarms amongst his bagged peanuts, and that he was sure that they were living on the oil in the nuts. In previous years he had found that many of the nuts had been dry and shrivelled when he was ready to plant."

"20 Feb. 1956. Stored peanuts and sorghum at Katherine N.T.A. Farm swarming with black bugs according to manager. Several bags of peanuts at Berrimah sent up from Katherine a month or so previously, showed heavy insect damage . . ." (Mainly Rice Moth and various beetles. Some bugs present.)

"17 Apr. 1956. Inspection of dozen bags of peanuts stored for two years in shed at 205 mile farm (Katherine N.T.A. Farm). Thousands of peanut trash bugs swarming over bags, over tin walls of shed, and in and over nearby machinery and grass. Many of them actively feeding on peanuts, even in the shell. Most of the peanuts are depleted of oil, and are spongy and white."

"2 May 1956. Peanut trash bugs at Katherine migrating out of sheds to house. Gammexane 4 per cent dust applied heavily around sheds—gave good control."

PEANUT TRASH BUGS (Lygaeidae).

"These bugs seem to be present wherever peanut trash or peanuts shelled or unshelled are stored on N.T. farms, and it is quite obvious that they cause serious losses in oil content, being able to feed right through the shell into the interior of the kernals. Also observed feeding on sorghum grains.

"RAE (A) 35: 216; 36: 44. *Aphanus* (Lygaeidae) in Nigeria 24 May 1956. Also present in and on ripening sunflower heads at Berrimah N.T.A. Farm.

"27 July 1956. Bugs still present at Berrimah Farm, also being found in lettuce plants.

"8 Aug. 1956. Visit to W. Christie's, Katherine, by T. Officer Moore. Reports that there bugs have been bad, and he considers that growing sunflowers has bred them up. They are even attacking pumpkins, which they honeycomb. When a pumpkin is kicked, large numbers of bugs fly out!" (I can't think of anything else that could have been confused with the bugs by this person.)

"Oct. 1956. Bill Alexander reports that he has had very little trouble with peanut trash bugs this season. Late rains prevented him from either drying out his dug crop, or digging out the remainder. The previous season there were many bugs about, and seed used for planting had numerous small bruises in the kernels."

SUNFLOWER.

"24 May 1956. Sunflower plants at Berrimah Farm with heads almost mature. Heads infested with moderate number of peanut trash bugs.

"8 Aug. 1956. Sunflower heads from Banyan Farm, Bachelor, very poor. . . . (caterpillar damage) . . . quite a number of peanut trash bugs also in sample."

PEANUT TRASH BUGS *Aphanus sordidus* ("Groundnut Bug").

'Groundnut Cultivation in India.' Farm Bulletin No. 2. Indian Council of Agricultural Research.

"The Groundnut bug has been reported to cause appreciable damage to groundnut in Bombay. The bugs appear in large numbers and suck the oil out of the kernels both in the field and on the drying floor and occasionally from stored material."

"Recorded from Madras on stored groundnuts, from Burma in millet heads. From Bombay, attacking groundnuts both during and after the harvest, also infests Sesamum and *Carthamus tinctorius.* Attacks may be prevented by putting the nuts into thick sacks immediately they are gathered. RAE (A)5: 101."

Elasmolomus v-album (Stål 1859)

Plate 19, fig. D

Rhyparochromus v-album Stål, 1859, Kongl. svenska Fregatten Eugenies Resa Om. Jordan etc. 1851-1853. Zool. 1, Insecta: 247.

Pachymerus (*Elasmolomus*) *v-album* Stål, 1874, Kongl. svenska Vetensk. Akad. Handl., 12(1): 161.

Aphanus v-album Barber 1958, Insects of Micronesia 7(4): 215.

Aphanus australis Distant, 1901, Ann. Mag. nat. Hist., (7) 8: 502.

Elasmolomus australis Scudder, 1962a, Canad. Ent., 94(7): 767.

Elasmolomus insularis Kirkaldy, 1908, Proc. Linn. Soc. N.S.W., 33: 360.

Aphanus (Elasmolomus) insularis China, 1930, Insects of Samoa 2(3): 138.

We have seen specimens of this species from Java (which Barber equates with the Philippine and Micronesian *v-album*), Timor, North Queensland, and Fiji and all are certainly the same species. The Javan specimen and one Australian tend to be brownish, and the others blacker, but this is hardly a specific difference. The Australian specimens have a general transverse darkening on the corium inwardly from the dark spot on the margin ⅔ of the way back, but so also does one of the three Timor specimens. In all other respects the specimens are identical. *Pachymerus nereis* was described from Lifu, but Kirkaldy's generic placing and his description leave little doubt that his material belongs to this species, or to the next.

Head dark brown to black with a silvery pilosity; eyes concolourous, ocelli reddish. First segment of antennae black or brownish with five or six robust spines, one near base on interior margin, another on the same margin about halfway, another between this and apex but on the superior margin, and an apical inner cluster of three or four; second segment yellowish brown vaguely infuscated at apex, third black or brown, pale at base; fourth with basal half pale yellowish brown, apical half blackish or brown.

Pronotum luteous to yellowish brown with anterior lobe within the reflexed margins (except two small luteous points or streaks along anterior margin), two spots on each lateral reflexed margin, one near apex and the other almost at base, and numerous punctations on the hind lobe blackish or brown.

Scutellum black or brown with a prominent V-shaped apical luteous or yellowish brown mark which bears a few fuscous punctations.

Legs yellowish, apices of tibiae, fore femora (except at apex), and a broad sub-apical band to the second and third femora black or dark brown.

Hemelytra luteous to yellowish brown with numerous fuscous punctations for the most part arranged in longitudinal lines but also some areas of scattered punctations. Corium with four distinct black spots two on the exterior margin, one past the half way mark towards the apex and the other at apex, a third spot in the middle of the disc in the apical quarter and a fourth near inner margin and its apex. Membrane fuscous, with elongate lightenings, principally on the veins.

Underside dark brown to blackish with light patches above insertions of coxae, hind upper angles of pro- and metasterna, and extreme lateral margins of abdomen on segments V and VI.

Rostrum reaches mid coxae, mainly pale. Antennal ratio 30-35: 75-82: 65-71: 75-90.

Length: 4.90-5.40 mm.

Specimens seen from Java, Timor, Fiji, Northern Australia.

Distribution: Indonesia, Philippines, Micronesia, Australia, Fiji, Tonga, Solomon Is. (but see note under next species).

Australian records: N.W. Australia, Troughton Is., J. O. Walker (B.M.). 1 female, Claudie R., N. Queensland, May 1914, O. MacGillivray (N.M.). 1 female, Daly R., Northern Territory (S.A.M.).

It may very well be that the distribution of *v-album* is much more extensive than we have claimed here. An examination of the types of *E. transversus* (Signoret) from Madagascar, *E. consocialis* (Dist.) from Seychelles and *E. lineosus* Dist. from Burma and Ceylon, indicates that a single species may be involved, ranging from Africa to Tonga. In this case, the oldest name in the complex appears to be *v-album*. Such a distribution is quite credible in view of the almost parallel distribution of *E. sordidus*. This problem is being considered further by G.G.E.S.

Elasmolomus papuanus (Distant 1901) nov. comb.

Plate 24, fig. D

Aphanus papuanus Distant, 1901, Ann. Mag. nat. Hist. (7)8: 502.

Head chocolate brown, with silvery pilosity. Eyes concolorous, ocelli reddish. First segment of antennae brown with eight or nine robust spines, four or five of them at apex. Second and third apical half of fourth segment a paler brown; basal half of fourth yellowish.

Pronotum luteous yellow with anterior lobe between the reflexed margins (except two obsolete luteous marks on the anterior margin), two spots on each lateral reflexed margin, one at middle of fore lobe and the other almost at the hind angles, and numerous punctations on the hind lobe brown.

Scutellum brown and with a V-shaped apical yellowish mark bearing a few brown punctations.

Legs yellowish, fore femora (except at apex) and a broad subapical band on the second and third femora brown.

Hemelytra brownish with numerous fuscous punctations for the most part arranged in longitudinal lines but also some areas of scattered punctations. The basal half of the lateral margins, a pre-apical spot and a basal streak running back paralleling the outer margin paler, yellowish. Membrane pale brown, extreme tip yellowish.

Underside chocolate brown with light patches above insertions of coxae, hind upper angles of pro- and meta-sterna and two small patches on margin of abdomen on segments V and VI.

Rostrum reaching mid coxae, mainly pale. Antennal ratio (to same scale as *v-album*) 42: 95: 85: 100.

Length: Female, 6.25 mm.

Distribution: Australia.

Australian record: 1 female, Dunk Is., North Queensland, Dec. 1932 P. MacIndoe (S.A.M.). Distant's type of this species cannot be found in the British Museum; it came from Peak Downs, also in Queensland. The species described here fits Distant's description fairly well although the head and anterior lobe of the pronotum and the underside of the tibiae and tarsi seem to be rather paler in colour. The size is about right.

This species is very little different to *v-album*; it is 25-30 per cent larger, paler overall and with much less contrast in its coloration. It could be a sub-species of *v-album* were it not that *v-album* already occurs in Queensland. It shares with both the Australian specimens of *v-album* a similar pattern of infuscation in the apical area of the corium, but this is also present in one Timor specimen of the latter species.

This distribution is quite credible in view of the almost parallel distribution of *E. sordidus*.

Note: **Elasmolomus nereis** (Kirkaldy 1905) nov. comb. *Pachymerus nereis* Kirkaldy, 1905, Trans. ent. Soc. Lond.: 347, pl. 18, fig. 7, described originally from Lifu, was recognized by one of us (G.F.G.) from several specimens in the Institut Francais d'Oceanic in Nouméa during a recent visit to New Caledonia. It is a distinct species of *Elasmolomus*, and differs from the other three in the very narrow pronotal laminae and more shiny appearance. It is small like *papuanus* and *v-album* and would run down to the former in our key.

Poeantius Stål 1865

Poeantius Stål 1865, Hem. Afr. 2: 154, 163. 1874, Kongl. Vetensk Akad. Handl. 12 (1): 159, 162. Distant, 1903, Faun. Brit. Ind. Rhynch. 2: 85. Breddin 1907, Dtsch. ent. Z.: 208. Bergroth 1918, Philipp. J. Sci., 13 (2 & 3): 84.

Naudarensia Distant, 1904, Faun. Brit. Ind. Rhynch. 2: 86.

Head triangular and with antennal tubercles not visible from above.

Pronotum with narrow lateral laminate carinae; disc with a distinct transverse impression; posterior margin concave; anterior lobe with punctures finer and denser than on posterior lobe.

Scutellum longer than wide; deeply punctate.

Fore femora not greatly swollen and with a small sub-apical spine and a few stiff hairs; posterior tarsi with the basal tarsomere twice as long as the combined length of the two distal tarsomeres.

Hemelytra usually with the apical half more or less castaneous and with a subapical pale spot to corium; membrane if with pale spots, then these basal; clavus with more than three rows of punctures; corium with rather dense punctuation.

Venter dark brown with coxal covers and posterior margin of metapleurae ochraceous.

Type species: *Rhyparochromus nigropictus* Stål, from Africa.

Both Breddin and Bergroth regarded *Poeantius* and *Naudarensia* as synonymous and we are accepting their opinion here. The species described by Distant (1918) as *Naudarensia rolandi* does not belong in the genus *Naudarensia*, but in *Udeocoris* Bergroth which is in the tribe Myodochini (Gross, 1962, Rec. S. Aust. Mus., Adelaide, 14(2): 391).

Poeantius australopictus sp. nov.

Plate 23, fig. D

Female. Head dark brown; antennae pale ferruginous with basal part of first segment, apex of second and most of third, dark brown; terminal segment of antennae without a distinct pale annulation; rostrum dark brown.

Pronotum with anterior half dark brown; anterior margin ferrugino-ochraceous; lateral carinae ochraceous with extreme posterior part dark brown; transverse impression laterally pale ferrugino-ochraceous, but centre distinctly fuscous; hind lobe of pronotum ochraceous with dense dark brown punctures.

Scutellum dark brown to black with tip ochraceous; apical half laterally slightly ferruginous to brown.

Legs dark brown with base of middle and hind femora ochraceous.

Hemelytra ochraceous with dark brown punctures; clavus with a dark brown longitudinal streak; corium with apical half from inner angle to anterior margin, dark brown, but with slender subapical ochraceous spot; membrane suffused with brown, but with a distinct pale spot near apical angle of corium.

Venter dark brown or slightly ferruginous, with coxal covers and posterior margin of metapleurae ochraceous.

Head inclined ventrally; antennal ratio 5: 13-14: 11-12: 16-17; rostrum almost reaching middle coxae. Pronotum not greatly wider than long, the width: length as 23-27: 20; disc with a distinct transverse impression near middle, ratio length of anterior lobe: length of posterior lobe, as 9-10: 8; lateral margins of pronotum distinctly concave near middle. Hemelytra macropterous.

Total length: 4.5 mm. (4.0-5.0 mm.).

Male. Similar to female, but usually a little smaller. Total length: 4.8 mm.

Type: A female, Queensland, Townsville, 1902 F. P. Dodd (B.M.). *Paratypes*: 1 sex undetermined, N.W. Australia, Kimberley district, Mjöberg (Stockholm); 1 female, Queensland, 17 Jan. 1929 Dr. K. K. Spence (A.M.); 1 female, Brisbane, 31 Apr. 1957, S. S. Sekhon (U.Q.); 1 male, 1 female, Normanton, R. Kemp (S.A.M.). 1 male, Northern Territory, Darwin, G. F. Hill (G. G. E. Scudder, Vancouver); 1 female, Townsville, 18 Apr. 1902 W. W. Froggatt (A.N.I.C.).

This species is similar to *P. variegatus* Distant from Africa in general appearance, but has the pronotum less tapering anteriorly and the claval white streak less evident. *P. australopictus* differs from *P. lineatus* Stål from the Philippine Is. by the shape of the pronotum and the coloration of the corium. In the latter species, the pronotum lacks a distinct transverse impression and the fuscous markings on the apical half of the corium do not extend to the anterior margin.

A single brachypterous female specimen in the Naturhistoriska Riksmuseum in Stockholm, with the data 'Queensland, Alice River (Mjöberg)' has the coloration of the corium similar to *P. lineatus* but on structure of the pronotum appears to be conspecific with the specimens of *australopictus* listed above.

It would appear that the specimens here considered to be a new species were, by Distant (1918) considered to conspecific with *P. lineatus*. This is not so as has been pointed out above.

Narbo Stål 1865

Narbo Stål, 1865, Hem. Afr. 2: 154, 163. 1874, Kongl. svenska Vetensk. Akad. Handl., 12(1): 159. Distant, 1903, Fauna Brit. Ind. Rhynch., 2: 85. Breddin, 1907, Dtsch. ent. Z., 208. Bergroth, 1918, Philipp. J. Sci., 13 (2 & 7): 84. Barber, 1958, Insects of Micronesia, 7(4): 216. Scudder, 1962a, Canad. Ent., 94(7): 769.

Laxamana Distant, 1906, Ann. Soc. ent. Belg. 50: 416.

Elongate insects; head porrect, eyes removed from anterior margin of pronotum; antennal tubercles clearly visible from above; antennae long and slender; first antennal segment extending beyond apex of head and subequal to head length.

Pronotum wider than long; distinctly punctate; with a conspicuous transverse impression; lateral margins weakly carinate and without a distinct laminate carina; lateral carinae ending abruptly on humeral angles; lateral margins deeply concave at level of transverse impression on disc; posterior margin slightly concave.

Scutellum longer than wide; distinctly punctate; basal half of disc excavate; disc with a vague Y-shaped elevation.

Legs slender and elongate fore femora slender and with a row of short spines along ventral surface; hind tarsi with basal tarsomeres more than twice combined length of the two distal tarsomeres; tibiae with short fine hairs and longer, outstanding, stout hairs; apex of tibiae with a circle of stout setae.

Hemelytra distinctly marked with brown and ochraceous; corium with a more or less distinct pale subapical spot; membrane with a faint pale spot apically; clavus with more than three rows of punctures; corium rather densely punctate.

Abdomen ventrally with a median longitudinal vague keel; male genital capsule with a small tubercle ventrally.

Type species: *Narbo longipes* Stål, from Borneo and Sarawak.

Narbo biplagiatus (Walker 1871)

Plate 20, fig. B

Noliphus ? biplagiatus Walker 1871, Cat. Het. B.M. 4: 177.

Rhyparochromus terminalis Walker 1872, Cat. Het. B.M. 5: 105.

Dieuches terminalis Lethierry & Severin, 1894, Cat. gén. Hém., 2: 220.

Narbo biplagiatus Distant 1901, Ann. Mag. nat. Hist. (7)8: 510.

Narbo biplagiatus Scudder 1962a, Canad. Ent., 94(7): 769.

Narbo metochoides Bergroth 1918, Philipp. J. Sci. (D) 13: 82. Barber 1958, Insects of Micronesia 7 (4): 217, fig.

Head dark brown to black; antennae ferrugino-ochraceous with first segment, apical parts of second and third, extreme base and apical part of fourth, dark brown; terminal antennal segment with a broad pale ochraceous annulation; rostrum ferruginous to brown.

Pronotum dark brown to black with lateral margins ochraceous and posterior lobe with a median longitudinal short pale streak on anterior part.

Scutellum dark brown to black with apex ochraceous and with two medio-lateral pale spots.

Legs ferrugino-ochraceous with apical parts of femora, apex of tibiae and tarsi dark brown.

Hemelytra dark brown to black with basal half of anterior margin and a subapical spot to corium, ochraceous; a short basal streak to clavus, an interrupted streak on corium near claval suture and a median spot to corium, ochraceous; membrane with basal part of some veins and apex, vaguely pale.

Venter dark brown with extreme postero-dorsal corner of metapleurae ochraceous and sterna V and VI with lateral pale spots.

Antennal ratio 13: 22: 18: 23; rostrum reaching middle coxae. Pronotal width: length, 23: 17. Fore femora with five or six ventral spines. Total length 10-10.3 mm.

Distribution: Ceram, Gilolo, Philippine Is., Palau Is., New Guinea, New Britain, Celebes, Sumatra, Queensland, Samoa, Caroline Is., Borneo, Sarawak, Assam, Indo-China, Samboangan and Java.

Australian records: New South Wales (Munich); Queensland, Cairns District, A. M. Lea (G. G. E. Scudder, Vancouver); Queensland, F. P. Dodd; Stewart River, Queensland, Jan. Feb. 1927 Hale & Tindale (S.A.M.).

TYPES EXAMINED AND THEIR DEPOSITION.

In the course of this work, the following types have been examined by one of us (G.G.E.S.): their location is noted.

Bosbequius australis Dist. in B.M.
Dieuches consanguineus Dist. in B.M.
D. distanti Bergr. not examined, deposition of type unknown.
D. finitibus Van Duzee in C.A.S.
D. longicollis (Dallas) in B.M.
D. maculicollis (Walk.) in B.M. (*D. atricornis* Stål in Stockholm).
D. notatus (Dallas) in B.M.
D. obscuripes (Walk.) in B.M.
D. oceanicus (Dist.) in B.M.
Elasmolomus nereis (Kirk.) type not examined, deposition unknown.
E. papuanus (Dist.) type not examined, not in B.M.
E. sordidus (Fab.) represented by two specimens, one male, one female, in the collection of Kiel examined by G.G.E.S. in Copenhagen. The female has been selected as lectotype and so labelled. (*Aphanus littoralis* Dist. also examined in B.M.)
E. v-album (Stål) in Stockholm (*E. insularis* Kirk in Hawaiian Sugar Planter's Association: *E. australis* (Dist.) in B.M.).
Narbo biplagiatus (Walk) in B.M. (*N. metochoides* Bergr. in Helsinki).

ACKNOWLEDGMENTS

This work was done while one of us (G.G.E.S.) was in receipt of a grant from the National Research Council of Canada and University of British Columbia. We wish to thank the following for loan of material and/or permission to study types in their care: Dr. W. E. China, Mr. R. J. Izzard and the Trustees of the British Museum (Nat. Hist.); Mr. H. B. Leech (California Academy of Sciences); Dr. E. Kjellander (Naturhistoriska Riksmuseum, Stockholm); Dr. W. Forster (Zoologische Sammlung des Bayerischen Staates, Munich); Dr. J. W. Evans (Australian Museum Sydney); Dr. L. Hoberlandt (Narodni Museum, Prague); Dr. K. H. L. Key (C.S.I.R.O., Canberra); Mr. A. N. Burns (National Museum of Victoria, Melbourne); Dr. W. D. L. Ride (Western Australian Museum, Perth); and Dr. T. E. Woodward (University of Queensland, Brisbane).

ABBREVIATIONS

The following abbreviations of names are used for collections from which material has been obtained for studies in this paper.

A.M.—Australian Museum, Sydney; A.N.I.C.—Australian National Insect Collection, formerly the collection of the C.S.I.R.O., Division of Entomology, Canberra; B.M.—British Museum (Nat. Hist.) London; C.A.S.—California Academy of Sciences, San Francisco; Munich—Zoologische Sammlung des Bayerischen Staates, Munich; N.M.—National Museum, Melbourne; Prague—Narodni Museum, Prague; S.A.M.—South Australian Museum, Adelaide; Stockholm—Naturhistoriska Riksmuseum, Stockholm; U.Q.—University of Queensland, Department of Entomology, Brisbane; W.A.M.—Western Australian Museum, Perth; and W.A.R.I.—Waite Agricultural Research Institute, Adelaide.

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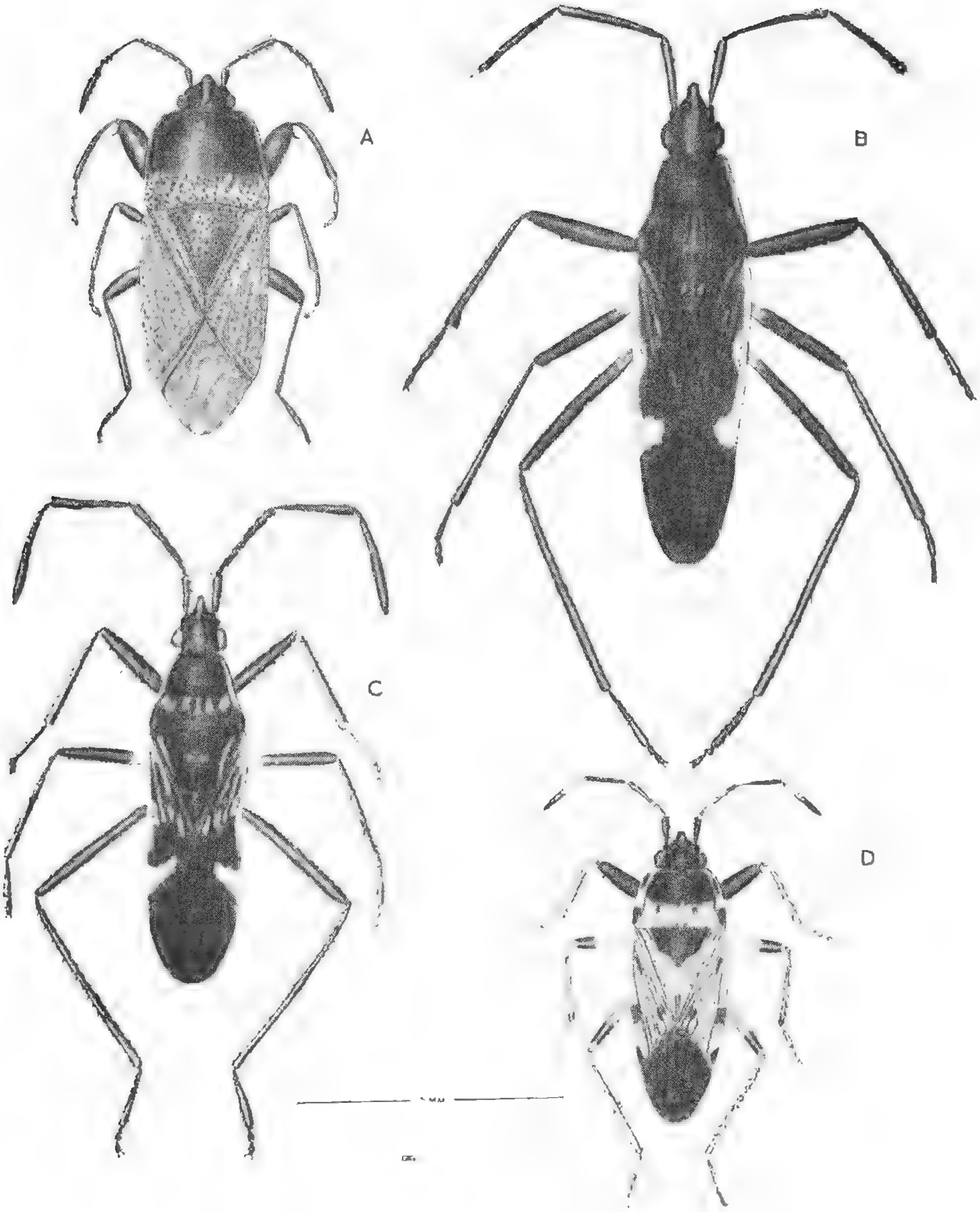
LEGENDS TO PLATES

PLATE 19.

Fig. A. *Bosbequius australis* Distant.
Figs. B and C. *Dieuches longicollis* (Dallas).
Fig. D. *Elasmolomus v-album* (Stål).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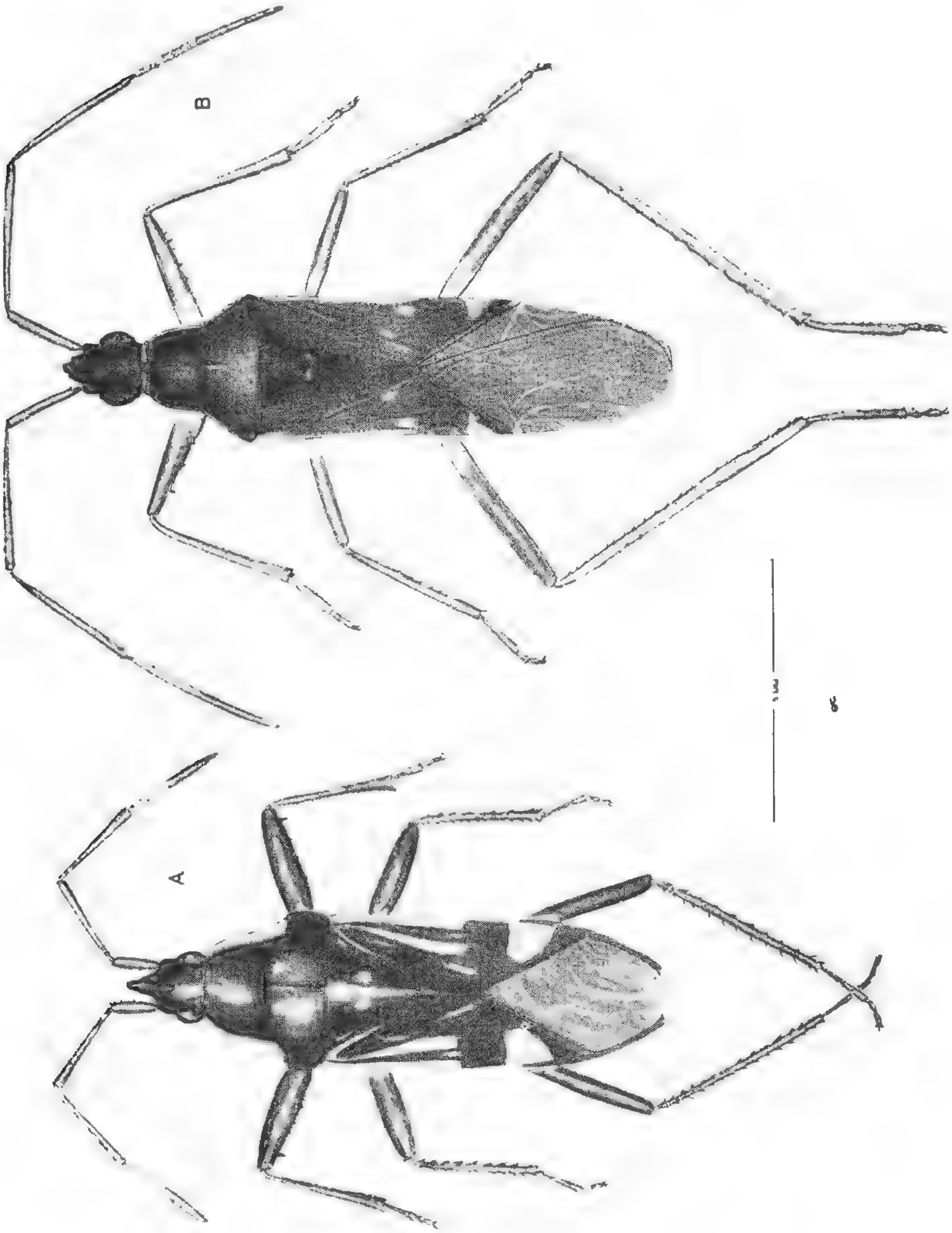
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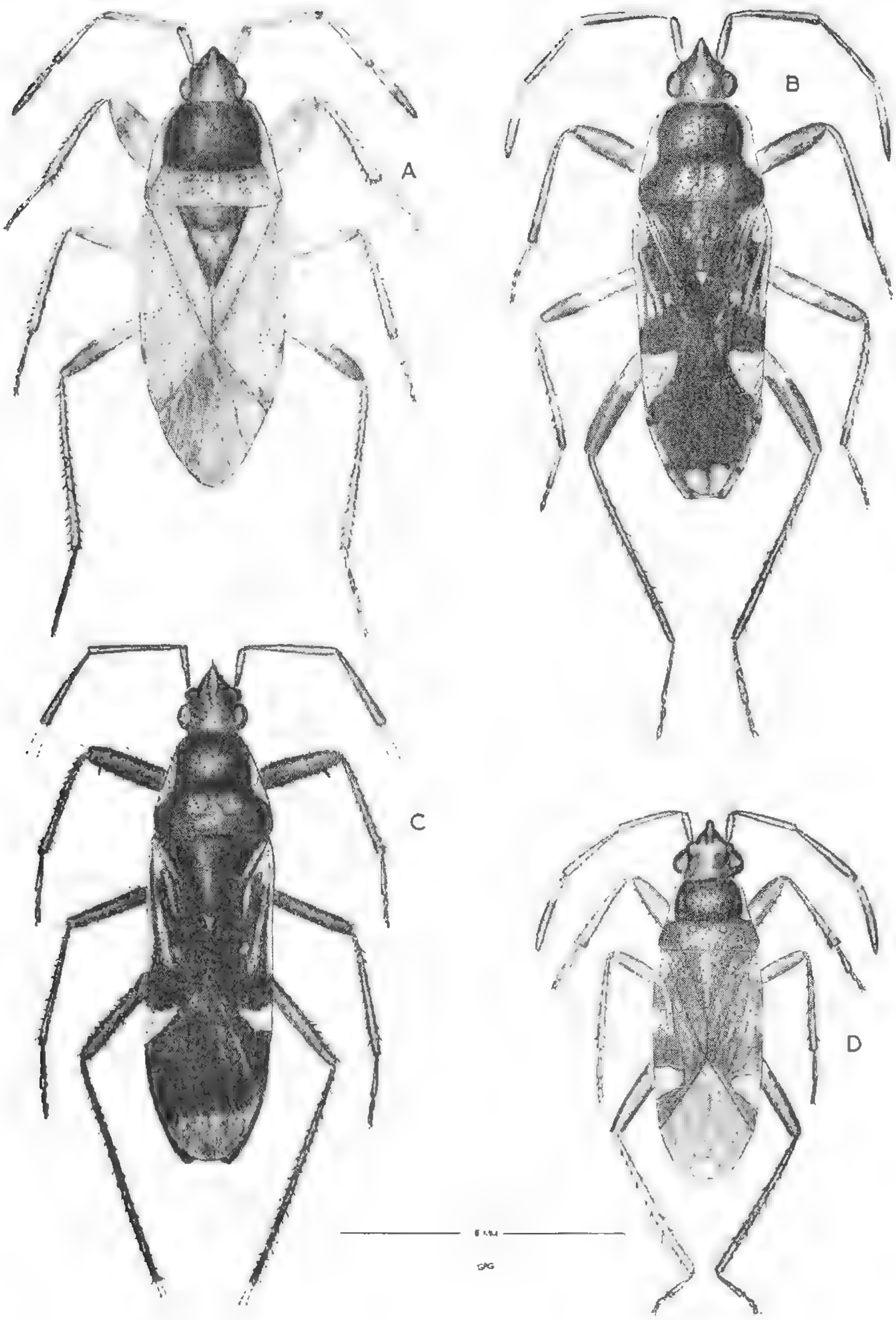
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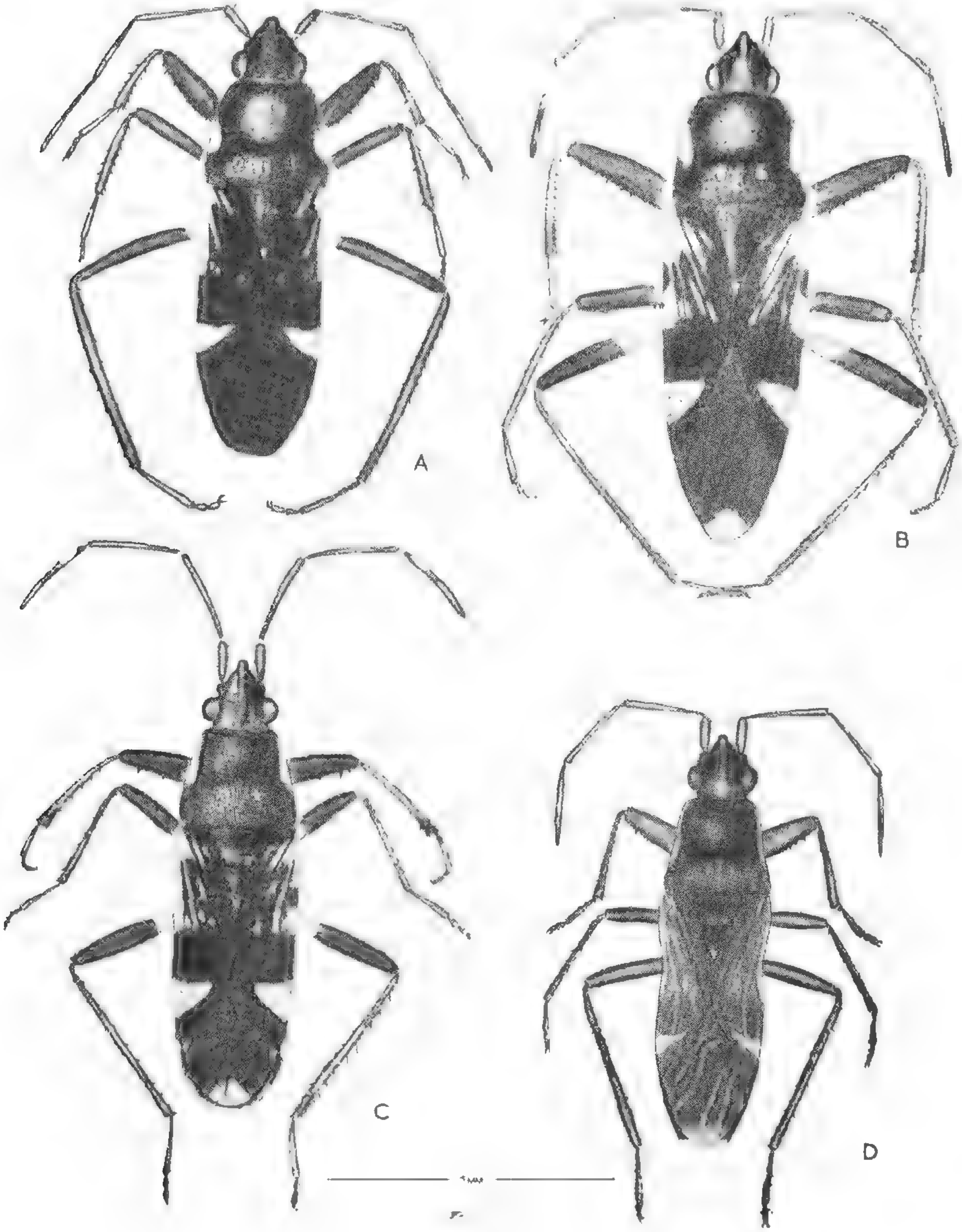
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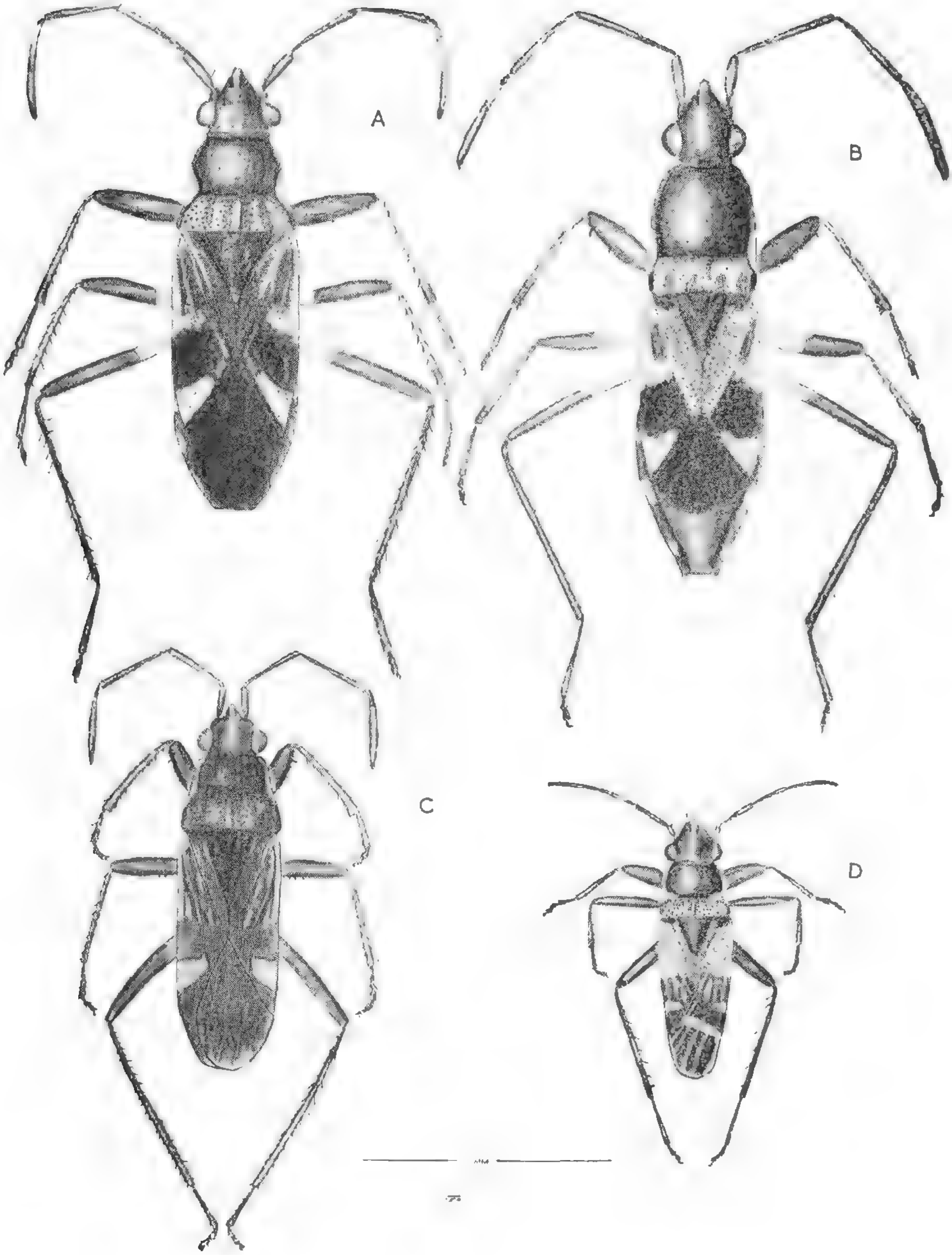
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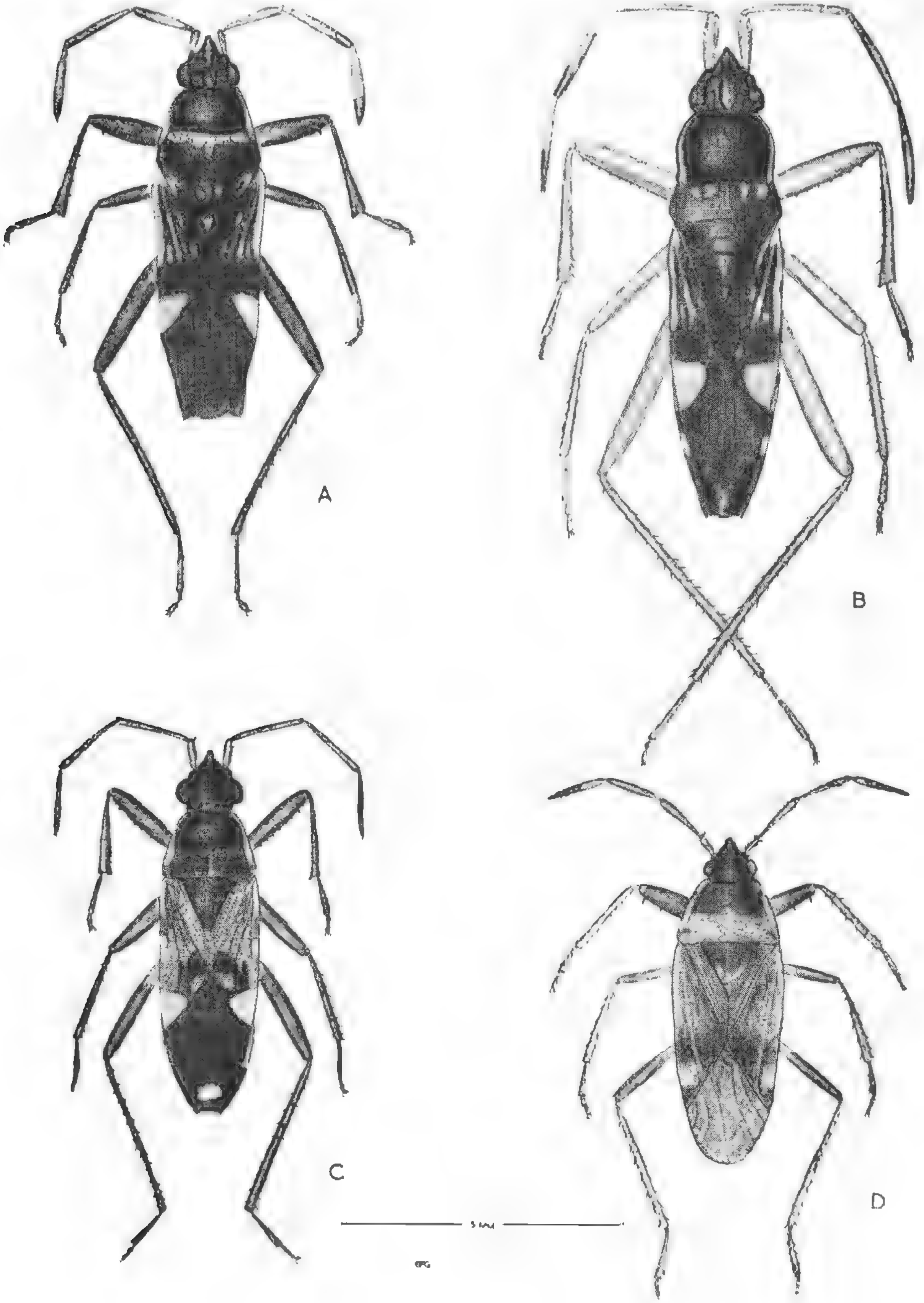
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PLATE 20.

Fig. A. *Dieuches grandicus* sp. nov.
Fig. B. *Narbo biplagiatus* (Walker).

PLATE 21.

Fig. A. *Elasmolomus sordidus* (Fabr.).
Fig. B. *Dieuches consanguineus* Distant.
Fig. C. *Dieuches hirsutus* sp. nov.
Fig. D. *Dieuches enigmaticus* sp. nov.

PLATE 22.

Fig. A. *Dieuches maculicollis* (Walker).
Fig. B. *Dieuches distanti* Bergroth.
Fig. C. *Dieuches oceanicus* (Distant).
Fig. D. *Dieuches obscuripes* (Walker).

PLATE 23.

Fig. A. *Dieuches notatus* (Dallas).
Fig. B. *Dieuches nudus* sp. nov.
Fig. C. *Dieuches oceanicus* (Distant).
Fig. D. *Poeantius australopictus* sp. nov.

PLATE 24.

Fig. A. *Dieuches finitimus* Van Duzee.
Fig. B. *Dieuches torpidus* sp. nov.
Fig. C. *Dieuches scutellatus* Distant.
Fig. D. *Elasmolomus papuanus* (Distant).

AQUATIC AND SEMIAQUATIC HEMIPTERA TAKEN IN PORTUGUESE TIMOR BY G. F. GROSS OF THE SOUTH AUSTRALIAN MUSEUM[1]

By Herbert B. Hungerford and Ryuichi Matsuda

Summary

Since the material sent us by the Basel Museum in Switzerland turned up several new species from Timor, we knew that this lot would at least add new distributional records. This it has done although only four familes are represented: Notonectidae, Gerridae, Hydrometridae and Micronectidae.

AQUATIC AND SEMIAQUATIC HEMIPTERA TAKEN IN PORTUGUESE TIMOR BY G. F. GROSS OF THE SOUTH AUSTRALIAN MUSEUM[1]

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NOTONECTIDAE

Anisops nasuta Fieber. "Pantai Macassar, Oe-Cusse, Timor Português Feb. 14 and 18, 1961 G. F. Gross" 4 males, 4 females. A new record for Timor.

Anisops timorensis Brooks. Same label as above. 1 male, 1 female, 1 nymph.

GERRIDAE

Limnometra ciliata Mayr. "Pantai Macassar, Oe-Cusse, Timor Português Feb. 14 and 15, 1961 G. F. Gross" 1 male, 1 female. While this is a new record for Timor it is to be expected to occur, for we have previously recorded it from the Lesser Sunda Islands.

Limnogonus australis (Skuse). "Pantai Macassar, Oe-Cusse, Timor Português Feb. 14 to 23, 1961 G. F. Gross" 64 adults, both apterous and macropterous; four of them are kept at the University of Kansas. 90 nymphs.

Tenagogonus robustus Hungerford and Matsuda. "Estacao Zootécnica and foot of Mundo Perdido nr. Ossú, Timor Português, Mar. 9, 1961 G. F. Gross" 1 male, 1 female: "Pantai Macassar, Oe-Cusse, Timor Português Feb. 19, 1961 G. F. Gross" 1 male, 1 female. All of these are apterous. Timor is a new record for this species which was previously known from East Java and West Sumba.

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(1) Contribution No. 1166 from the Department of Entomology, The University of Kansas. This is a by-product of a research project aided by a grant from the National Science Foundation.

HYDROMETRIDAE

Hydrometra maidli Hungerford and Evans. "Pantai Macassar, Oe-Cusse, Timor Português Feb. 14 to 23, G. F. Gross" 3 males, 3 females. This species was described from Sumatra and Java, and this is a new record for Timor.

MICRONECTIDAE

Micronecta sp. "Pante Macassar, Oe-Cusse, Timor Português Feb. 18, 1961 G. F. Gross" 3 females. While this is a new record for the genus occurring in Timor, males are needed to determine the species.

A NEW LARVAL NEOTROMBIDIUM (ACARINA, LEEUWENHOEKIIDAE) FROM BAT GUANO

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Summary

A new species of larval Neotrombidium, N. gracilipes (Acarina, Leeuwenhoekiidae) is described from a single specimen obtained from bat guano from Fig Tree Cave, Wombeyan, New South Wales.

Neotrombidium gracilipes sp. nov.
Fig. 1

Holotype larva: Shape, slightly engorged, broadly oval. Length of idiosoma 960μ, width 580μ.
Dorsum: With the scutum triangular with a broadly rounded anterior apex, furnished with three pairs of ciliated setae and a pair of fine filamentous sensillae shortly and sparsely ciliated distally, no trace of a crista, the lateral margins do not run in a straight and oblique line, but are roughly longitudinal and parallel from the antero-median setae to the antero-lateral setae which they contour, and then similarly to the postero-lateral setae which they outwardly surround, posterior margin lightly convex.

A NEW LARVAL NEOTROMBIDIUM (ACARINA, LEEUWENHOEKIIDAE) FROM BAT GUANO

By H. WOMERSLEY, South Australian Museum

Fig. 1

SYNOPSIS

A new species of larval *Neotrombidium, N. gracilipes* (Acarina, Leeuwenhoekiidae) is described from a single specimen obtained from bat guano from Fig Tree Cave, Wombeyan, New South Wales.

Neotrombidium gracilipes sp. nov.

Fig. 1

Holotype larva: Shape, slightly engorged, broadly oval. Length of idiosoma 960μ, width 580μ.

Dorsum: With the scutum triangular with a broadly rounded anterior apex, furnished with three pairs of ciliated setae and a pair of fine filamentous sensillae shortly and sparsely ciliated distally, no trace of a crista, the lateral margins do not run in a straight and oblique line, but are roughly longitudinal and parallel from the antero-median setae to the antero-lateral setae which they contour, and then similarly to the postero-lateral setae which they outwardly surround, posterior margin lightly convex. The antero-median setae, AM, and postero-lateral setae, PL, are fairly short and blunt, but the antero-lateral, AL, are long and tapering, the sensillae are shortly ciliated distally and arise from fairly large alveolae a little in front of PL. Dorsal surface posterior of the scutum with 31 pairs of tapering finely ciliated setae to 60μ long and arranged in irregular transverse rows of 4 to 6 setae. The Standard Data in micra are as follows: AW 29, LW 52, PW 89, SB 38, ASB 87, PSB 20, SD 107, AM-AL 35, AL-PL 70, AM 41, AL 64, PL 35, Sens. 90, SW 96.

Venter: As figured; coxae I and II separated by the width of the urstigma, all coxae with only one pair of slender ciliated setae, between coxae I with one pair of setae situated just off the inner margins of coxae, a single pair of setae between coxae III and posterior coxae III with 10 pairs of setae, all coxae with slight porosity.

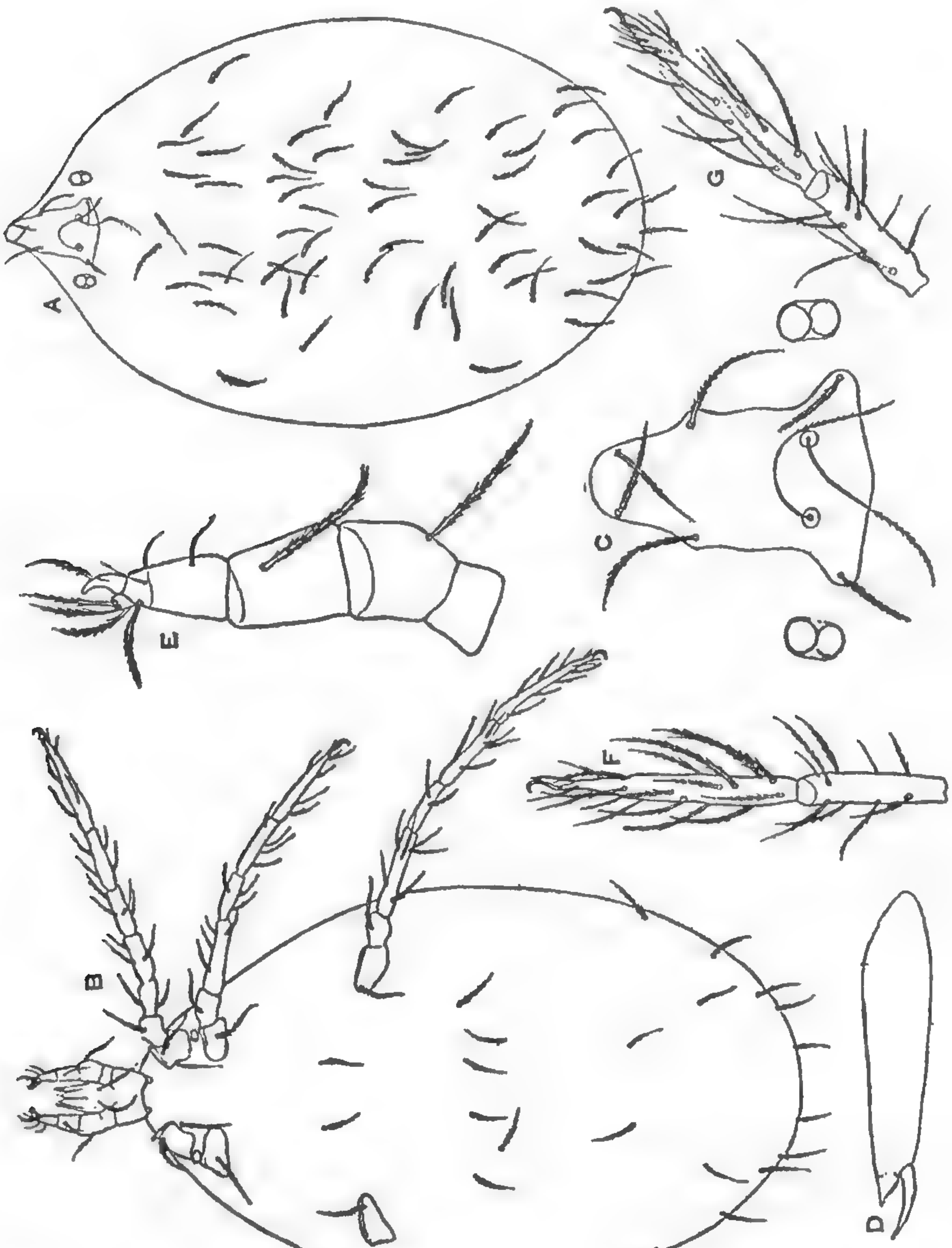

Fig. 1. *Neotrombidium gracilipes* sp. nov. Larva. A. dorsum, B. venter, C. dorsal scutum, D. mandible, E. palp, F. tibia and tarsus, leg I., G. same of leg III.

Mandibles (fig. D) long and narrow, with strong simple cheliceral blade. Palpi slender as figured, tibial claw bifid and tarsus small. Legs unusually slender, I and II 526μ long, III 620μ. Tibia and tarsi about 8 times longer than high, all tarsi with a single claw, tarsi I 154μ long by 17μ high, without any solenidia as far as can be seen, tibia I 99μ long, tibia and tarsi III as figured, tarsi 168μ long by 17μ high, and tibia 128μ long.

Locality: A single specimen from bat guano from Fig Tree Cave, Wombeyan, New South Wales, 21st August 1960.

Remarks: This species differs from the other described larvae of *Neotrombidium, barringunense* Hirst, *tenuipes* (Wom.) and *tricuspidum* Borland, in the very slender legs. It also differs from the first larva to be described, *barringunense* (Southcott, 1954) in that coxae I and II are separated by the width of the urstigma, as is also the case in *tenuipes* and *tricuspidum*. These coxae are also similarly separated in *Monunguis streblida* Wharton, the genus of which Southcott 1954 synonymised with *Neotrombidium*, but which the writer has shown in a current paper on other grounds to be valid. It seems therefore that the separation or otherwise of coxae I and II is not of generic importance.

Adults of a new species of *Neotrombidium, N. gracilare* Wom. and described in a current paper (Trans. Roy. Soc. S. Austr., Adelaide, 1962) are known from bat guano from other bat caves in Eastern Australia and it is probable that the larva described above is that of *N. gracilare*. The occurrence of two different species of *Neotrombidium* in such a localized specialized biotope as bat guano seems extremely unlikely. However, until the larva and adult can be correlated by rearing, a new specific name is proposed.

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"MONUNGUIS" WHARTON 1938, A VALID GENUS (ACARINA, TROMBIDIOIDEA)

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Summary

The genus Monunguis Wharton 1938 was erected for a new larval species of mite, Monunguis streblida Wharton, found parasitic on bat flies (Diptera, Streblidae) from caves in Yucatan, Mexico. Considered by recent workers as synonymous with the genus Neotrombidium Leonardi 1901 (fam. Leeuwenhoekiidae) it is now shown, on re-examination of a paratype, to be valid and that while probably more nearly rated to Neotrombidium it does show some relationship to Johnstoniana George 1909 = Rohaultia Ouds. 1911 (fam. Johnstonianidae).

"MONUNGUIS" WHARTON 1938, A VALID GENUS (ACARINA, TROMBIDIOIDEA)

By H. WOMERSLEY, South Australian Museum

Fig. 1-2

SYNOPSIS

The genus *Monunguis* Wharton 1938 was erected for a new larval species of mite, *Monunguis streblida* Wharton, found parasitic on bat flies (Diptera, Streblidae) from caves in Yucatan, Mexico. Considered by recent workers as synonymous with the genus *Neotrombidium* Leonardi 1901 (fam. Leeuwenhoekiidae) it is now shown, on re-examination of a paratype, to be valid and that while probably more nearly rated to *Neotrombidium* it does show some relationship to *Johnstoniana* George 1909 = *Rohaultia* Ouds. 1911 (fam. Johnstonianidae).

The paratype examined, one of the three specimens comprising the type and two paratypes in the United States National Museum, is redescribed and refigured.

Genus **Monunguis** Wharton

Wharton G. W. 1938, Acarina of Yucatan Caves. Carnegie Institute of Washington, Publ. 491, pp. 150-151, fig. 25-28.

Type *Monunguis streblida* Wharton.

In 1938 Wharton (*loc. cit.*) erected the genus *Monunguis* for a curious larval trombidiform mite, *Monunguis streblida* found parasitic upon bat flies, *Pterellipsis araneae* Coq. and *Trichobius dugesii* Towns. (Diptera, Streblidae) from the Cinque de Mayas Cave, Tekax, Yucatan, Mexico.

The description was very brief and the figures, especially that of the dorsal scutum, somewhat crude and puzzling. Since the original description few references have been made to the genus and species, and it was overlooked both in Vitzthum's big work in Bronn's Tiereich, vol. 6 Acarina, 1943, and in Sig Thor and Willman's work in Das Tiereich, Lfg. 71b. 1947. In a brief note in 1947 Wharton (9) suggested the possibility of the synonymy of *Monunguis* with *Neotrombidium* Leonardi 1901. The next reference appears to be that of Baker and Wharton 1952 (1) when they listed the genus in the subfamily Trombellinae.

In 1954 Southcott (5) in describing the larva of *Neotrombidium barringunense* Hirst, discussed its generic affinities with *Monunguis* but without having had access to any of the original material. He concluded that *Monunguis* was synonymous with *Neotrombidium* Leonardi 1901. Borland J. G. 1956 (2) was the first and only one who has in any degree re-examined a specimen of the original material and, although he gave little or no further data and no figures, on comparison with the larva of *Neotrombidium tricuspidum* he was of the opinion that as more data became available the two genera might be validly separated.

With a view to clearing up the question I have been endeavouring for some time to trace the deposition of the original material and lately, through the good offices of Dr. D. E. Johnston of the Institute of Acarology, Agricultural Experiment Station, Wooster, Ohio, I have been privileged to receive on loan from Dr. J. F. Gates Clarke and Dr. E. W. Baker of the Division of Insects, Smithsonian Institution, Washington, D.C., a paratype slide of *Monunguis streblida* Wharton, and I am indeed grateful to these gentlemen for the opportunity of redescribing the species.

The paratype slide examined is labelled as follows:
on the left hand side as—

> "*Mononyx streblida* n.g. n.s.p. G. W. Wharton, Duke U. Co-type"

Alongside this label is another red one marked—

> "Co-type No. 1393, U.S.N.M."

on the right hand side as—

> "On *Trichobius dugesii*, Cinque de Mayas Cave, Tekax, Yucatan. A. S. Pearse coll. no. 162, July 29-1936 Lot. 36-31564".

Dr. Baker informs me that the other two slides in the collection are similarly labelled, except that both specimens were from *Pterellipsis araneae*. One of these is marked "Type", the other "Co-type".

The generic name used on the slides "Mononyx" was evidently changed before publication on realization of its having been used earlier. Before considering the affinities and validity of the genus, the species is redescribed and refigured from the paratype specimen seen, as follows:

Monunguis streblida Wharton

Wharton, G. W. 1938, Acarina of Yucatan Caves. Carnegie Institute of Washington, Publ. 491, p. 150-151, fig. 25-28.

Fig. 1, A-B, 2, A-E

Larva: Body elongate oval (pear shaped; Borland), nearly twice as long as wide, 514μ by 298μ. Scutum triangular with anterior apex, with 3 pairs of blunt ciliated rod-like setae and one pair of long filiform nude sensillae arising from large alveolae, a crista is distinctly present extending from the more or less straight posterior margin

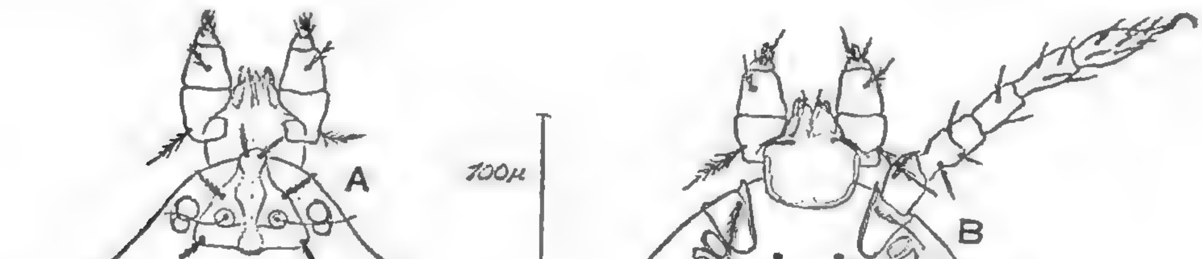

Fig. 1. A-B. *Monunguis streblida* Wharton. A. dorsum, B. venter (Original, from paratype).

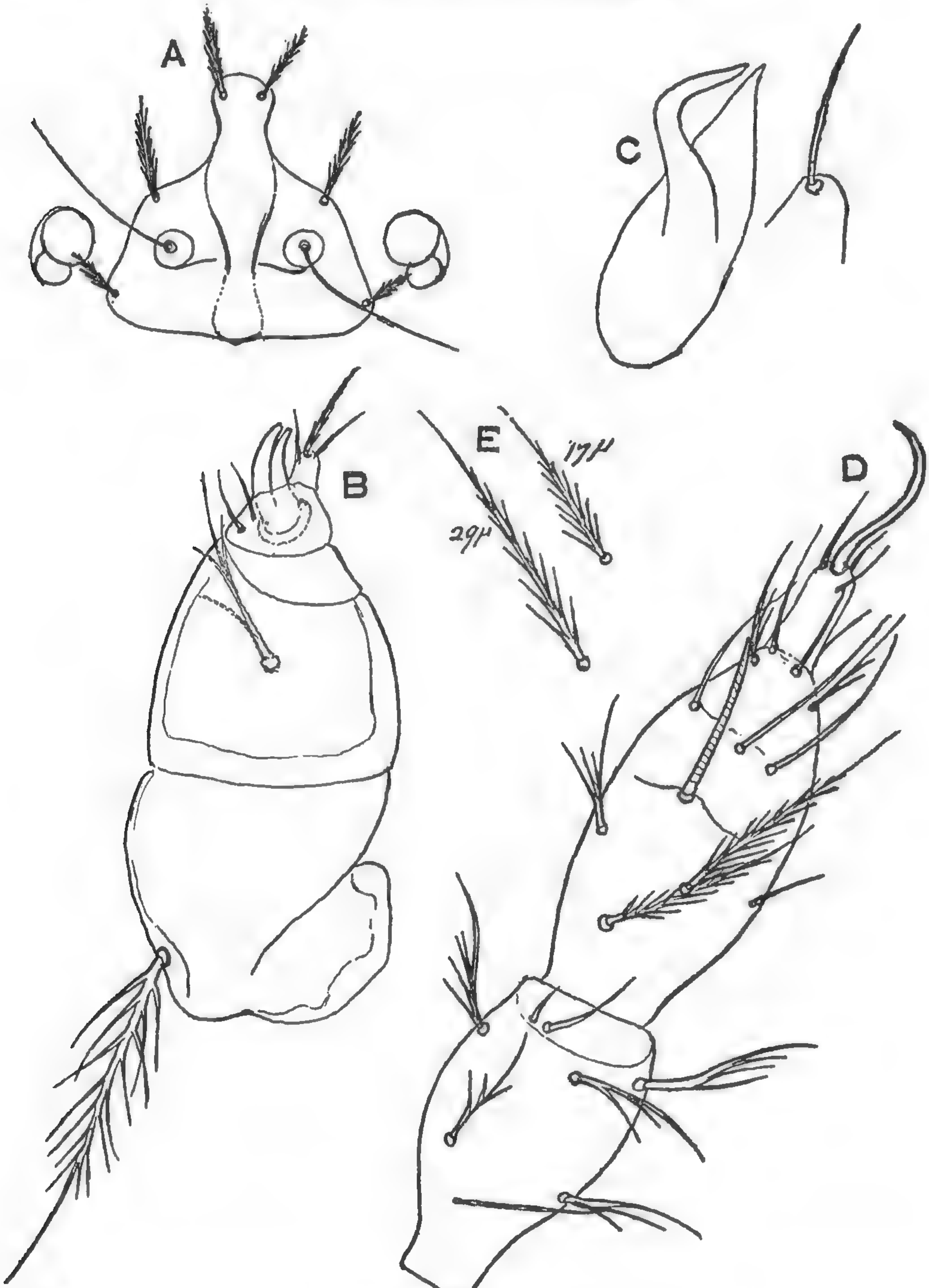

Fig. 2. A-E. *Monunguis streblida* Wharton. A. dorsal scutum, B. palp, C. chelicerae, D. tibia and tarsus of leg I, E. dorsal setae (Original, from paratype).

to the anterior apex of the scutum, it is more clearly defined anteriorly, between the sensillae bases and at the posterior end; in between these areas it is less demarcated and bulbous. The Standard Data in micra are AW 9, MW 46, PW 73, SB(p) 35, A-P 67, AL 26, ML 29, PL 15, Sens. 58, SD 78. The eyes are large, two on each side, on ocular shields in line with the sensillae bases, posterior eyes the smaller. Chelicerae with well sclerotised and strongly angled blade without teeth. Galeal seta short and as far as can be seen shortly ciliated. Palpi stout, femur with a long strongly branched seta as figured, genu with a similar shorter seta, tibial setae not clearly seen but claw strong thick and bifurcate, tarsus not clear.

Dorsum with approximately 50 pairs of ciliated tapering setae, lengthening posteriorly from 17 to 30μ, in irregular transverse rows. Ventrally with the coxae as figured, I and II separated (as stated by Wharton (6)), but only narrowly so and for not more than the width of the urstigma, II and III widely separated, all coxae with a long tapering ciliated seta. Between coxae I with a pair of setae, between coxae III with two pairs of setae, and posterior of coxae III with approximately 30 piars of setae similar to dorsal.

Legs: All 6-segmented, although there is an indefinite division of the femur, leg I 293μ long, II 283μ, III 370μ, tarsus I 72μ long, each tarsus with a single strong claw 24μ long, tarsi I and II each with a long solenidia and other sensory setae as in fig. 2D.

AFFINITIES OF THE GENUS

In his original description of *Monunguis*, Wharton considered it to be closely related to *Rohaultia* Ouds. 1911 (4) (now regarded as synonymous with *Johnstoniana* George 1909) agreeing with it in the possession of two pairs of eyes, a crista, a rostrum, divided femora and a single seta on each coxa, but differing in having only a single pair of pseudostigmata and a single claw on each tarsus. In a brief research note in 1947 (7) however, he raised the possibility of *Monunguis* being synonymous with *Neotrombidium* Leonardi 1901 as follows: "The larvae of *Neotrombidium* have not been previously recognized. However they have been described under the generic name *Monunguis* . . . ."

In 1954 Southcott (5) described the larva of *Neotrombidium barringunense* Hirst, and in discussing the relationship with *Monunguis streblida* Wharton stated that "There are so many resemblances between these larvae that there appears little doubt that *Monunguis* and *Neotrombidium* are congeneric and as the latter genus has priority it must take precedence over *Monunguis*."

In 1956 Borland (2) in discussing the genus *Neotrombidium* in the United States, described a new larval species *N. tricuspidum* as well as the adults reared from the larvae. In this paper he also refers to two larvae of a second but undescribed species. He had the opportunity of examining a "co-type" of *Monunguis streblida* Wharton, and concludes "it is the opinion of the writer that while recognition of the synonymy (with *Neotrombidium*) may be expedient at this time, as more data becomes available the two genera may be validly separated. At present consolidation of the group appears desirable." Borland unfortunately did not give any fresh figures of the specimen examined and only made the following comments on morphological features: "The larval scutum of *M. streblida* bears an incipient crista which is not present in the known larvae of *Neotrombidium* although upon careful comparison faint traces can be seen in *Neotrombidium*. Therefore with respect to the scutum, *M. streblida* differs from *Neotrombidium* larvae in degree only. However both the form of the body setae and the body shape seem to set *M. streblida* apart from the larva of *Neotrombidium*. The setae, particularly those of the scutum, are much more plumose, bearing strong branches, and are more numerous on the dorsum than in either *M. tricuspidum* or *N. barringunense*, whose setae are sparse and with indistinct barbs. *Monunguis streblida* is pear-shaped, as opposed to the ovoid body form of *N. tricuspidum* and *N. barringunense*. The cheliceral blades of *M. streblida* are peculiarly modified".

Southcott in his 1954 paper (5), and again in 1957 (6), notes that although Wharton did not figure the ventral surface he did state that coxae I and II were separated as in "*Rohaultia*". He also noted that the single tarsal claw and the shape and chaetotaxy of the scutum strongly resembled that of *Neotrombidium*, but that the curious structure between the scutal sensillae figured by Wharton has no comparable structure in *Neotrombidium* and might from its appearance be an artefact. From the figures now given, of the paratype specimen examined it will be seen that while the shape and chaetotaxy of the scutum do resemble those of *Neotrombidium* there is a very definite crista which is moderately wide posteriorly, narrows between the posterior sensillae and then swells out, narrows again and then expands to a rounded knob on which are situated the anterior median pair of setae. From this shape it is easy to trace that shown diagrammatically by Wharton. The anterior pair of setae on the crista are not sensillary in form but stiff and shortly ciliated as are the ML and PL scutal setae, whereas the posterior sensillae laterad of the crista are sensilliform. In *Johnstoniana* (*Rohaultia*) the anterior pair are sensilliform and on a fairly well defined sensillary area, shaped very much as in *M. streblida.*

In his intensive study of the Johnstonianidae, Newell 1957 (3) has shown fairly conclusively that the anterior pair of setae, although very much modified and resembling the other setae of the scutum are but modifications of the anterior pair of scutal sensillae. In this feature then, plus the presence of a distinct crista, *M. streblida* resembles *Johnstoniana* rather than *Neotrombidium.*

In *Neotrombidium* coxae I and II are not separated, except outwardly, by the urstigma while in *M. streblida* they are separated for the whole length and for the width of the urstigma. In *Neotrombidium* spp. and also the genera of Johnstonianidae coxae I carries two pairs of fine ciliated setae, one at the anterior lateral corners and one on the extreme inner margin (off, but close to in a new species at present being studied by the writer), with the exception of *Johnstoniana errans* (Johnst.) which from Oudemans figure of 1912 lacks the inner setae of coxae I (this is the only figure I have been able to see and I have not seen actual specimens). Oudemans also does not figure any setae in the intercoxal area of coxae I. In *M. streblida,* however, coxae I bear only one seta, rather strongly ciliated at the anterior lateral angles, and there is a pair of similar setae in the intercoxal area. Here *Monunguis* appears to be distinct from both *Neotrombidium* and the genera of the Johnstonianidae.

The palpal tibial claw is bifid in *Monunguis* as in *Neotrombidium* while in *Johnstoniana errans* it is simple, but in *J. latiscuta* Newell, it is terminally bifid, and in *Centrotrombidium distans* Newell it is simple. In *Diplothrombium monoense* Newell and *D. cascadense* Newell (Johnstonianidae) it may be simple or bifid. This character therefore seems to be of little, if any value generically.

In having only a single tarsal claw on all legs, *Monunguis* agrees with *Neotrombidium.* The various larval species of Johnstonianidae possess tarsi with two or three claws.

The dorsal setae in the species of *Neotrombidium* are generally long and sparse, and about 12-15 pairs, whereas in *Monunguis streblida* they are shorter, much more numerous and about 50 pairs in number. In this respect the chaetotaxy resembles that of the many species of *Acomatacarus,* family Leeuwenhoekiidae, to which the genus *Neotrombidium* has been assigned.

CONCLUSION

Monunguis must therefore be considered as a valid genus distinct from *Neotrombidium.* It does, however, show some features relative to Johnstonianidae, but on the whole its affinities lie more with *Neotrombidium* than elsewhere as shown by the following table of larval characters.

	Johnstonianidae	*Neotrombidium*	*Monunguis*
Crista	+	—	+
A. M. setae	sensilliform	setiform	setiform
Coxae I and II touching	—	+ (1)	—
Coxal setae	1.1.1. or 2.1.1.	2.1.1.	1.1.1.
Tarsal claws	two or three	one	one
Palpal tibial claw	simple or bifid	bifid	bifid
Dorsal setae	sparse	sparse	numerous
Leg segmentation		7.6.6.	6.6.6.

(1) Only in *barringunense* Hirst; separated by width of urstigma in *tenuipes* (Wom.) and *tricuspidium* Borland, as well as in a new species being described elsewhere.

Until such times as the adults should be known, *Monunguis* must be considered as a valid genus belonging to the Leeuwenhoekiidae different form, but closely allied to *Neotrombidium* Leonardi.

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NEW RECORDS OF DIARTHROPHALLIDAE (ACARINA) WITH THE DESCRIPTION OF THE HITHERTO UNKNOWN LARVAL STAGE

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Summary

A small collection of Diarthrophallidae (Acarina) in the Coll. Samsinák in the Entomological Institute of the Czechoslovak Academy of Sciences in Praha has been submitted to the author by Dr. K. Samsinák. The specimens, seven in all, were collected from Passalid beetles from Brazil and India in the National Museum in Praha, all of which were of long standing.
Five of the specimens were from the vicinity of Sao Paulo, Brazil, all of which can be referred to known species. One of these however, is a larva of Diarthrophallus duodecimpilosa (Lomb.) and the first larval Diarthrophallid to be described.

NEW RECORDS OF DIARTHROPHALLIDAE (ACARINA) WITH THE DESCRIPTION OF THE HITHERTO UNKNOWN LARVAL STAGE

By H. WOMERSLEY, South Australian Museum

Fig. 1-7

SYNOPSIS

A small collection of Diarthrophallidae (Acarina) in the Coll. Samsinák in the Entomological Institute of the Czechoslovak Academy of Sciences in Praha has been submitted to the author by Dr. K. Samsinák. The specimens, seven in all, were collected from Passalid beetles from Brazil and India in the National Museum in Praha, all of which were of long standing.

Five of the specimens were from the vicinity of Sao Paulo, Brazil, all of which can be referred to known species. One of these however, is a larva of *Diarthrophallus duodecimpilosa* (Lomb.) and the first larval Diarthrophallid to be described.

The other two specimens from Coimbatore, India are a female and a larva of a new species, *Brachytremella epiphenus,* the first record of the family from India.

The specimens are all figured in detail and are to be returned to the Academy of Sciences in Praha.

Family DIARTHROPHALLIDAE

The following small but extremely interesting collection of mites of the family Diarthrophallidae has been submitted to me for study and determination by Dr. K. Samsinák of the Biological Institute of Czechoslovakia and I tender to him my sincere thanks for the opportunity of so dong.

The specimens, seven in all, were recovered by Dr. Samsinák from old specimens of Passalid beetles in the collections of the National Museum in Praha. Five of them, all from beetles from the vicinity of Sao Paulo, Brazil can be referred to known species; one specimen however, is the first true Diarthrophallid larva to be described. The other two specimens are from a Passalid from Coimbatore, India, one a female, the other a larva. These are the first Diarthrophallids to be described from India, and belong to a new species *Brachytremella epiphenus* sp. nov.

Genus **Diarthrophallus** Trägårdh

Trägårdh I. 1946. Ent. Meded., 24 (6), 371.

Type: *Uroseius quercus* Pearse et al, 1936.

Diarthrophallus quercus (Pearse *et al.*)

Fig. 1 A-C, 2 A-B

Uroseius quercus Pearse et al 1936, Ecol. Monogr., 6: 478, fig. 31-34.

Diarthrophallus quercus Trägårdh 1946, Ent. Meded., 24(6): 371-380, fig. 1-2, 4-5; Womersley 1961, Trans. Roy. Soc. S. Austr., 84: 11, 29-32, fig. 1A, 2A-B.

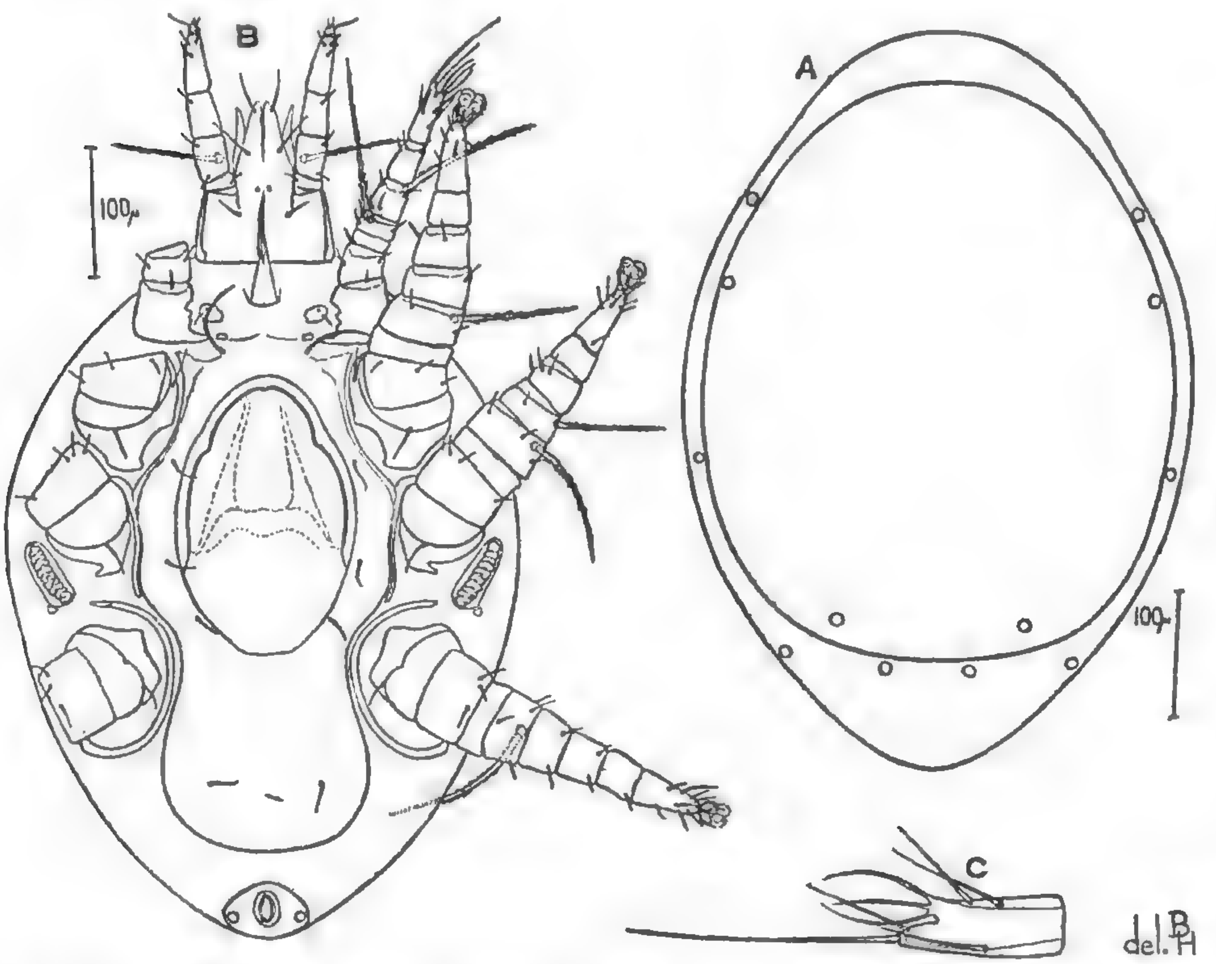

Fig. 1. A-C *Diarthrophallus quercus* (Pearse *et al*) female. A, dorsum; B, venter; C. tarsus of leg I. (Specimen from Coll. Samsinák.)

This species is represented in the collection by two specimens, one a female from a Passalid *Veturius cephalotes* from Sao Paulo, Brazil, the other a deutonymph from *Passalus* (*Petrejus*) sp., also from Sao Paulo. Both specimens are figured. The female, fig. 1 A-C, unfortunately lacks all the long dorsal setae; it measures 573μ (idiosoma) in length. The deutonymph, fig. 2 A-B measures 386μ in length.

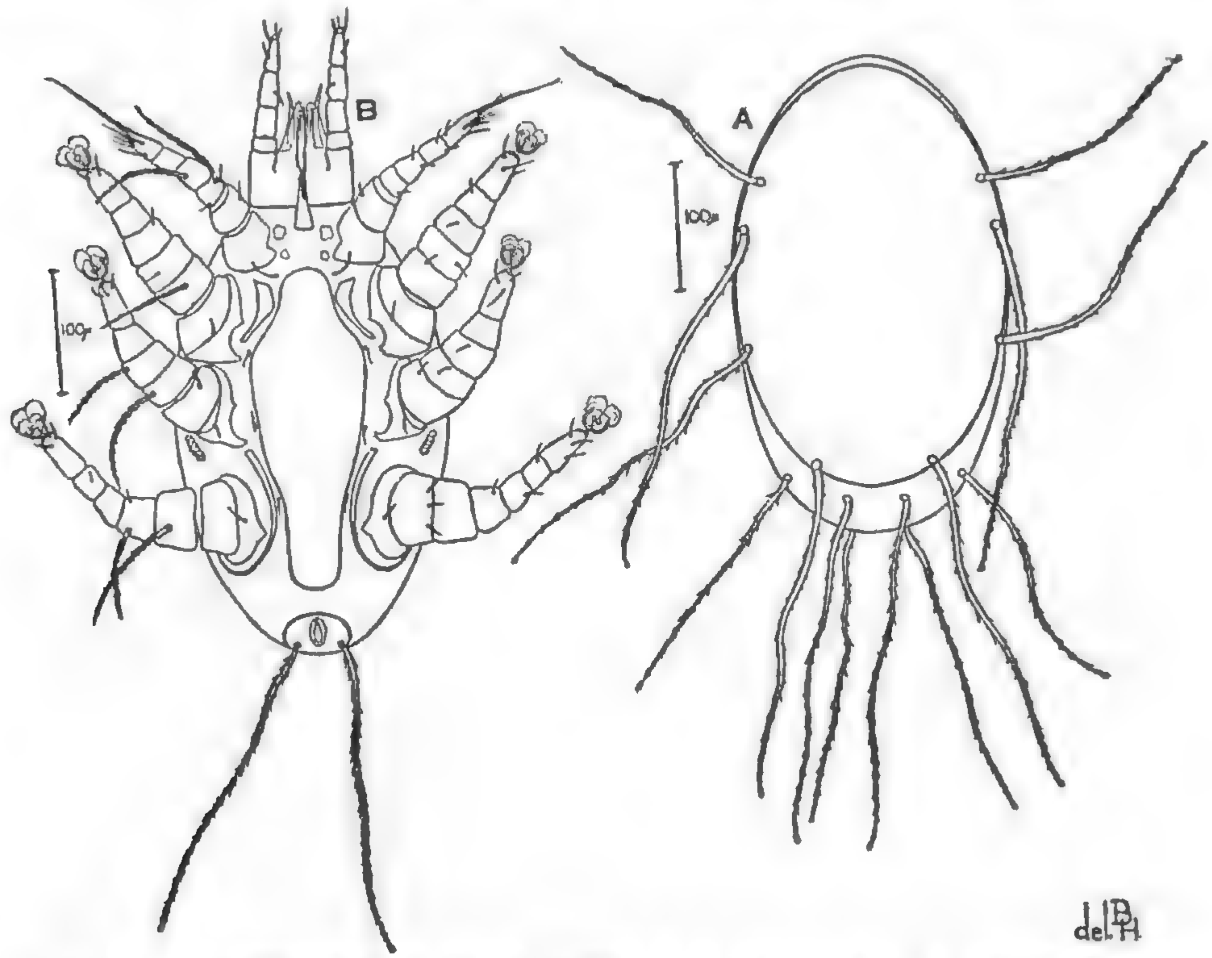

Fig. 2. A-B *Diarthrophallus quercus* (Pearse *et al*) deutonymph. A, dorsum; B, venter. (Specimen from Coll. Samsinák.)

Diarthrophallus duodecimpilosa (Lomb.)

Fig. 3 A-B, 4 A-B, 5 A-B

Passalobia duodecimpilosa Lombardini 1938, Mem. Soc. ent. ital., 17(1): 48, fig. V, VII.

Diarthrophallus simitis Trägårdh 1946, Ent. Meded. 24(6): 380-384, fig. 6-7.

Diarthrophallus duodecimpilosa, Womersley 1961, Trans. Roy. Soc. S. Aust., 84: 32-34, fig. 3 A-G.

Three specimens in the collection are referred to the species; one, a deutonymph was from the Passalid, *Veturius cephalotes* (ex Col. Nicker) and just labelled "America", but as this beetle is a South American species, it was most likely from the vicinity of Sao Paulo, Brazil, as with the host of the female of *D. quercus*. Of the other two specimens, both of which are from *Passalus* (*Phoronaeus*) *clypeomarginatus* from Brazil, one is a tritonymph, the other, the hitherto first larval Diarthrophallid to be described. The tritonymph, fig. 3 A-B measures 433μ (idiosoma) in length, and the deutonymph, fig. 4 A-B, 445μ. The larva is described as follows:

Larva morphotype, fig. 5 A-B. Idiosoma 249μ long, 192μ wide; gnathosoma 81μ long.

Dorsum: Fig. 5 A, with only two pairs of long slender ciliated and apically capitate setae, the anterior pair at about the mid-length of the idiosoma and 316μ long, the second pair subposterior and marginal to 220μ long. The dorsal shield covers most of the dorsum and is somewhat truncate posteriorly.

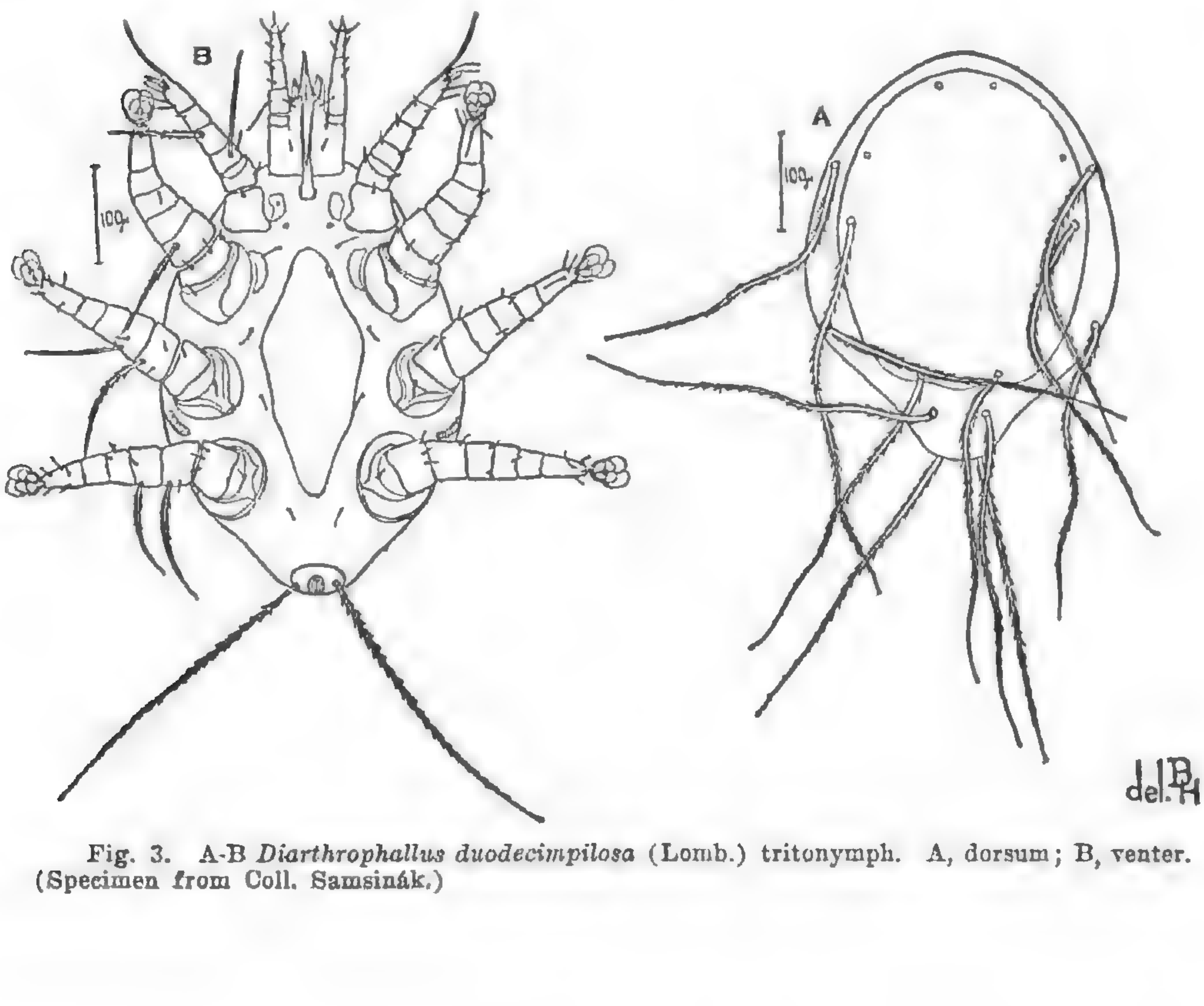

Fig. 3. A-B *Diarthrophallus duodecimpilosa* (Lomb.) tritonymph. A, dorsum; B, venter. (Specimen from Coll. Samsinák.)

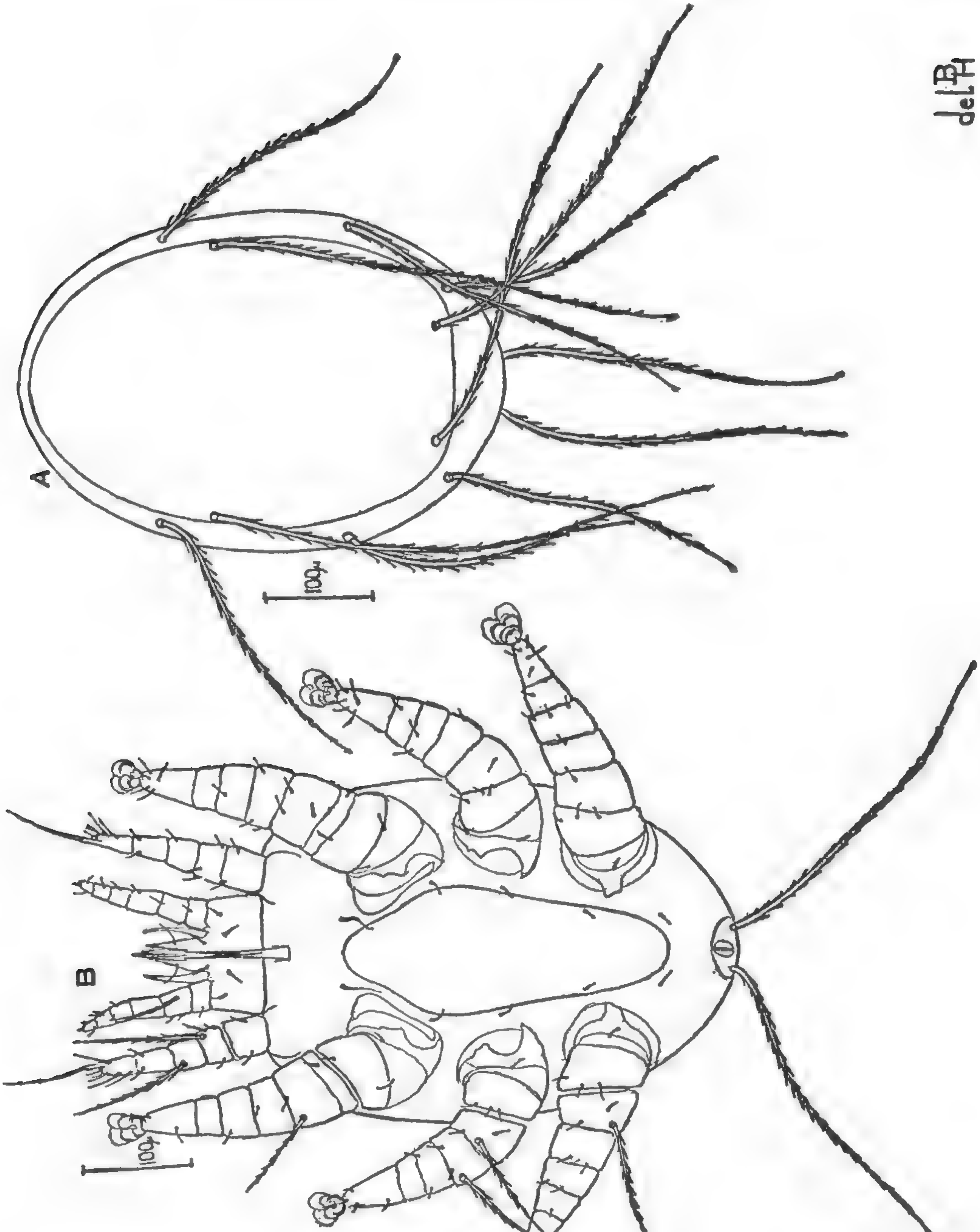

Fig. 4. A-B *Diarthrophallus duodecimpilosa* (Lomb.) deutonymph. A, dorsum; B, venter. (Specimen from Coll. Samsinák.)

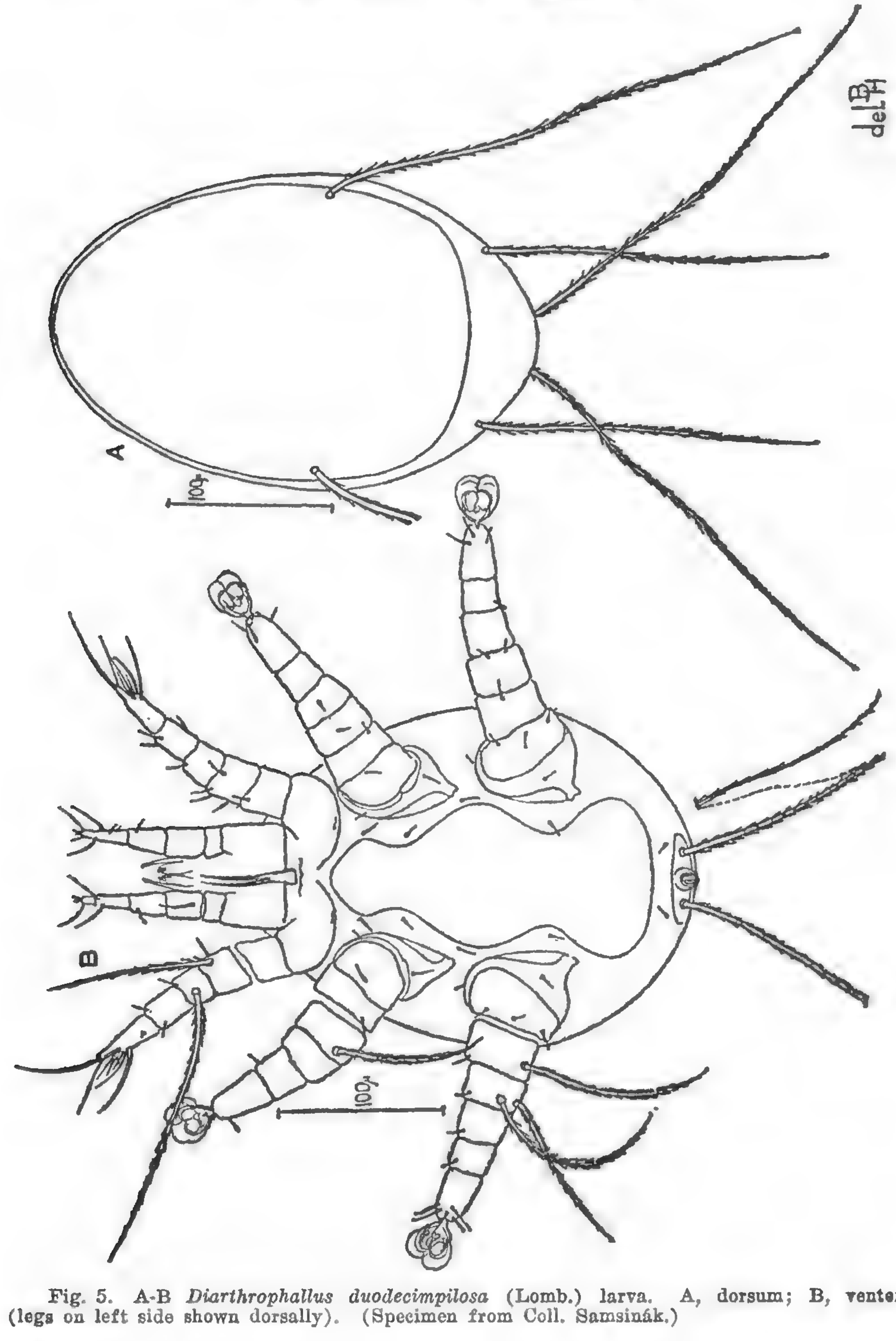

Fig. 5. A-B *Diarthrophallus duodecimpilosa* (Lomb.) larva. A, dorsum; B, venter (legs on left side shown dorsally). (Specimen from Coll. Samsinák.)

Venter: Fig. 5 B. Sternal shield 200μ long, 48μ wide between coxae II then contracting before widening to 62μ between coxae II and III and again contracting before expanding to 96μ posterior of coxae IV, its posterior margin is broadly rounded and fairly close to the margin of the anal shield; the sternal setae are all off the shield, two pairs between coxae II, one between coxae III, all are small and fine to 17μ long. Anal shield a transverse ellipse 53μ wide by 11μ deep, and furnished with two long slender apically capitate setae to 300μ long; there is a pair of short setae between the sternal and anal shields. Gnathosoma, chelicerae and palpi as in the later stages. Legs all rather thick and stout and directed forwards, I 6-segmented, tarsus apically bifurcate with long apical tactile seta, dorsally with a long strong and ciliated seta to 200μ on genu, and a rather shorter one on the femur, legs II and III 7-segmented, II with a long seta on telofemur, III with two long setae on telofemur and one on basifemur, tarsi of legs II-III with large pad-like ambulacra, without claws; legs I 178μ long, II and III 200μ. Peritreme entirely absent.

Remarks: This larva, the first true larval Diarthrophallid to be known is associated with *D. duodecimpilosa* only because it was from the same host, *Veturius cephalotes* from Brazil, as the deutonymph; it may however be that of *D. quercus*.

Genus **Brachytremella** Tragårdh

Trägårdh, I. 1946, Ent. Meded. 24(6): 384; Womersley H. 1961 Trans. Roy. Soc. S. Aust., 84: 11.

Type: *Brachytremella spinosa* Träg.

Brachytremella epiphenus sp. nov.

Fig. 6 A-B, 7 A-D

Types: Holotype female and morphotype larva in the "Col. Samsinák", a part of the collections of the Entomological Institute of the Czechoslovak Academy of Sciences, Praha.

Localities: Both female and larva from specimens of *Epiphenus stoliczkae* in collections of the National Museum of Czekoslovakia in Praha, from Coimbatore, India.

Female holotype: fig. 6 A-B. A broad oval shape, with idiosoma 442μ long and 312μ wide.

Dorsum: With the dorsal shield 389μ long, almost entirely covering the dorsum with the posterior margin truncate, furnished with two pairs of short tapering and apparently nude setae anterior

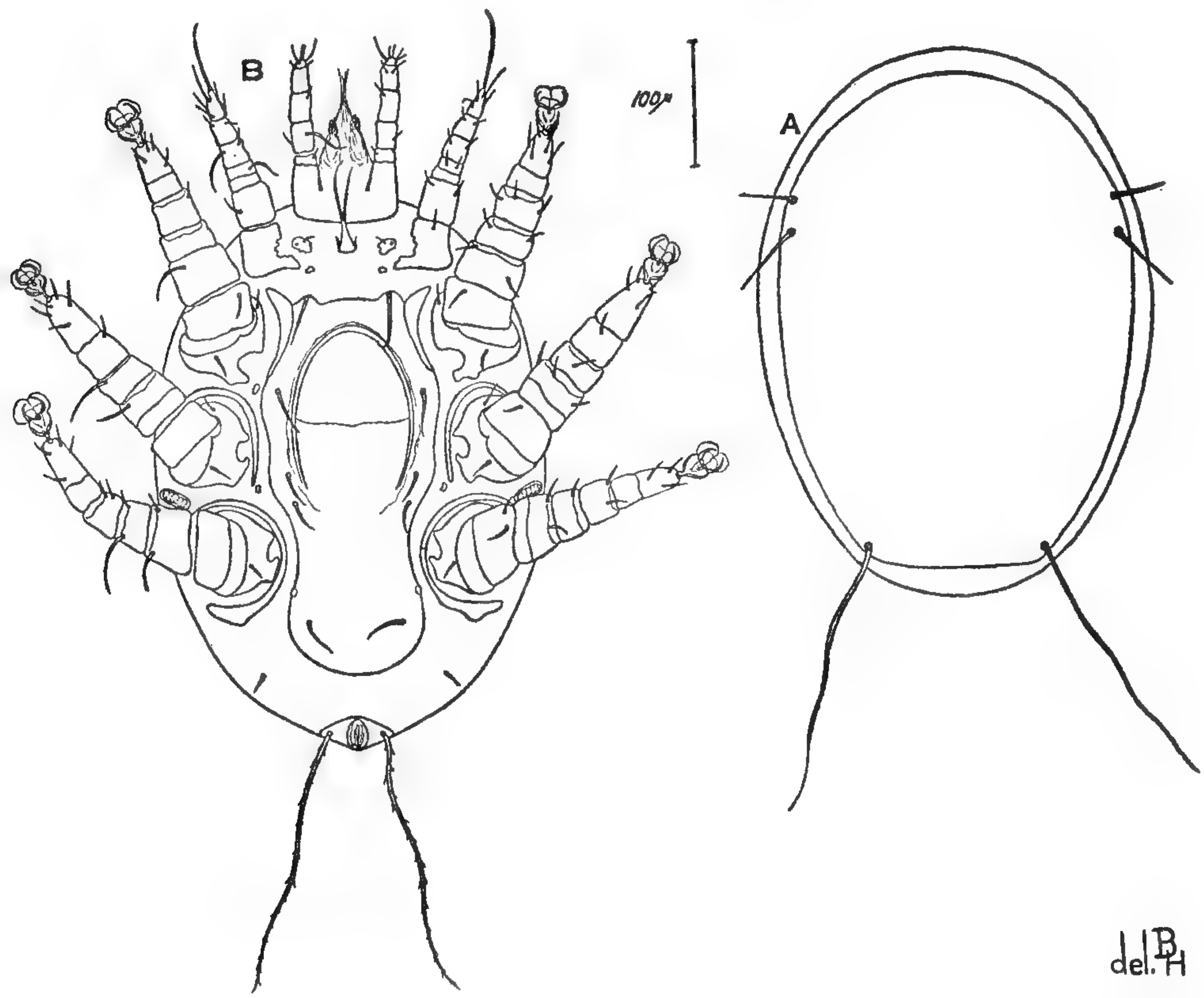

Fig. 6. A-B *Brachytremella epiphenus* sp. nov. female. A, dorsum; B, venter (legs on left side shown dorsally). (Specimen from Coll. Samsinák.)

of the mid-length, the anterior pair 38μ long, the other pair 58μ long, and at the postero-lateral corners of the shield with a long slender nude seta to 216μ long.

Venter: Sternal shield 307μ long extending well past coxae IV, 144μ wide at greatest width between coxae II and III, contracted between coxae II and again between coxae IV, with rounded posterior, furnished with 5 pairs of strong sternal setae, anterior pair 38μ long and between coxae II, second pair 34μ and third pair 29μ, these between coxae III, fourth pair of setae rather close to third but between anterior margins of coxae IV to 24μ long, fifth pair 29μ long and posterior of coxae IV. The genital shield is large, situated in the middle of the sternal shield between coxae II and III, 144μ long by 96μ wide and open posteriorly, or rather without a clear cut hinge line.

Endopodal shields distinct as figured. Anal shield small, transverse, with a pair of long slender setae to 192μ long and sparsely and shortly ciliated; on the cuticle and lateral on each side is a short fine seta. Gnathosoma as in the genus. Legs short and stout, directed forwards, I 163μ long, II 221μ, III 230μ, IV 240μ; tarsus of leg I apically bifurcate, with terminal tactile seta, coxae fragmented as figured, tarsi of legs II-IV with large pad-like ambulacra without claws; the long dorsal setae on the femur and genu of legs II-IV relatively short. Peritreme short, in line with anterior margin of coxae IV.

Larva, morphotype. A rather smaller species than the larva of *D. duodecimpilosa* described above. Idiosoma 268μ long, 165μ wide; gnathosoma 72μ long.

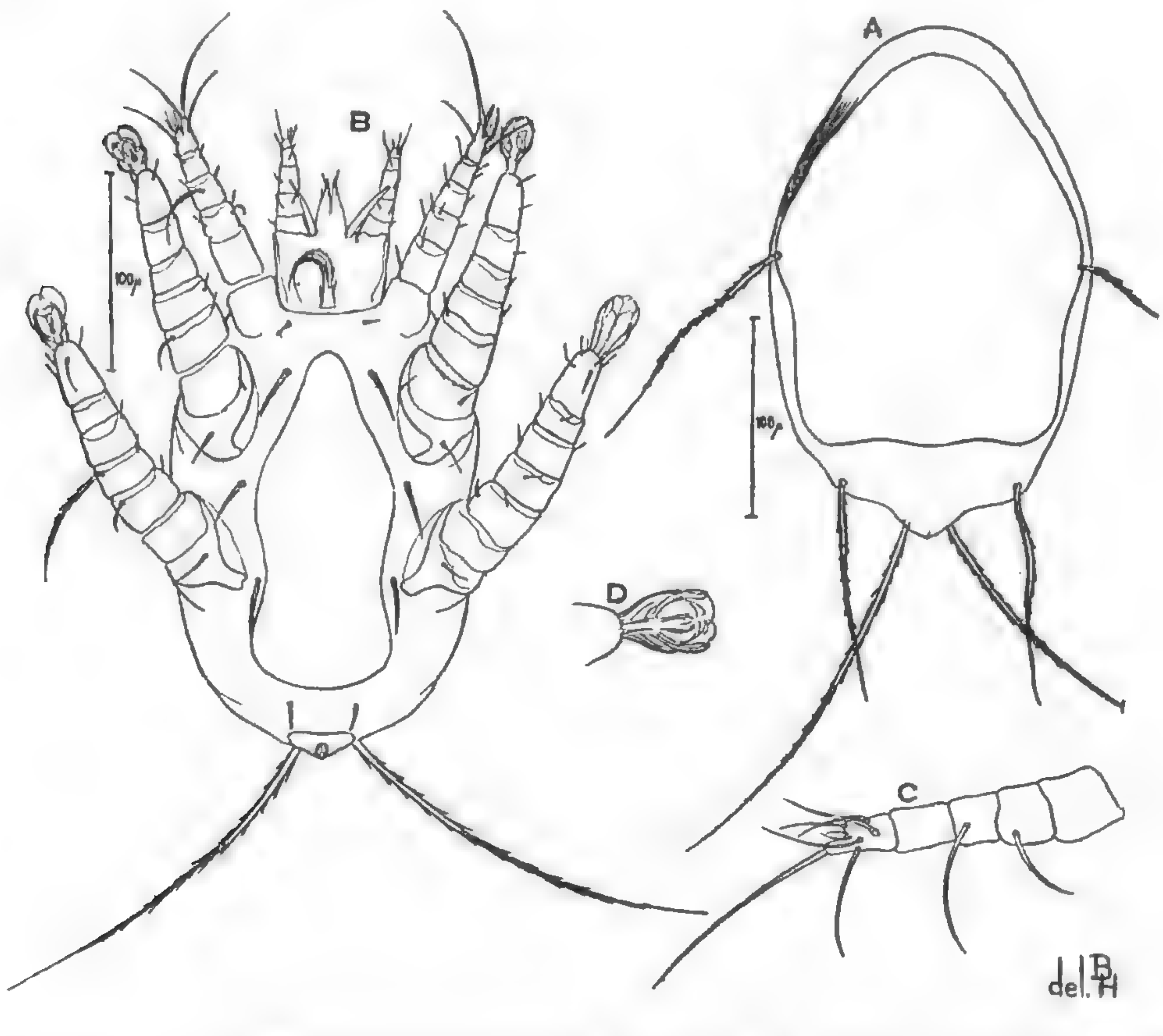

Fig. 7. A-D *Brachytremella epiphenus* sp. nov. larva. A, dorsum; B, venter (legs on left side shown dorsally); C, leg I; D, ambulacra of leg III. (Specimen from Coll. Samsinák.)

Dorsum: Fig. 7 A, with only two pairs of long slender ciliated and apically knobbed setae, the anterior pair at about the mid-length of the idiosoma, 125μ long, the second pair subposterior and marginal to 115μ long; the dorsal shield covers most of the dorsum except posteriorly, and its posterior margin is widely truncate and sinuous.

Venter: Fig. 7 B, as figured; sternal shield 168μ long, 29μ wide between coxae II, then gradually expanding to 67μ between coxae II and III, then contracting slightly before widening to 72μ behind coxae III, posterior margin broadly rounded and fairly widely separated from anal shield, with four pairs of sternal setae all situated off the sternal shield, setae I are small and fine and close to base of gnathosoma, II to IV are long, 29μ, and stout, a pair of medium setae between anal and sternal shields. Anal shield a transverse ellipse 43μ wide by 11μ deep, furnished with two ciliated capitate setae to 192μ long. Gnathosoma, chelicerae and palpi as in the preceding species. Legs all rather stout and directed forwards, I 6-segmented, II and III 7-segmented, tarsi of leg I apically bifurcate, with long apical tactile setae, the long seta on genu only 33μ, no very long setae on II, and only one to 48μ on telofemur of III; tarsi of legs II and III with large pad-like ambulacra without claws; leg I 115μ long, II 182μ, III 192μ.

Remarks: From the larva of the preceding species, *Diarthrophallus duodecimpilosa* (Lomb.), it differs strikingly in the smaller size, the less constricted sternal shield, and the very much stronger and stouter sternal setae II-IV.

ACKNOWLEDGMENTS

Sincere thanks are expressed to Dr. K. Samsinák for submitting his material to me for study and to my assistant Miss B. Hubbard for her careful drawings of the specimens and the typescript.

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TOTEMIC BELIEFS IN THE WESTERN DESERT OF AUSTRALIA PART II[1]

MUSICAL ROCKS AND ASSOCIATED OBJECTS OF THE PITJANDJARA PEOPLE

BY NORMAN B. TINDALE, CURATOR OF ANTHROPOLOGY,
SOUTH AUSTRALIAN MUSEUM

Summary

Large static (´kondala) or musical rocks, of the Pitjandjara tribes-people of the Western Desert of Australia are described.

Kondala stones may be incorporated either in arrangements of a formal character or stand alone. They may be given totemic names and identities; groups of them can denote families of ancestral beings. During ceremonies they may be decorated with painted designs and covered with the secret (´mina) blood taken from a vein in the arm. They are the "voices" of totemic ancestors and may be played by striking with hammerstones during male initiation, during female puberty ceremonies and as part of "increase" or "fattening" ceremonies, at which dances are enacted for the stimulation of growth of totemic animals of economic importance. A notable series of such musical rocks are described from Makurapiti, near Mount Agnes on the border of South and Western Australia.

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By NORMAN B. TINDALE, Curator of Anthropology,
South Australian Museum

Plates 25-26 and text fig. 1-11

SUMMARY

Large static ['kondala] or musical rocks, of the Pitjandjara tribespeople of the Western Desert of Australia are described.

Kondala stones may be incorporated either in arrangements of a formal character or stand alone. They may be given totemic names and identities; groups of them can denote families of ancestral beings. During ceremonies they may be decorated with painted designs and covered with the secret ['mina] blood taken from a vein in the arm. They are the "voices" of totemic ancestors and may be played by striking with hammerstones during male initiation, during female puberty ceremonies and as part of "increase" or "fattening" ceremonies, at which dances are enacted for the stimulation of growth of totemic animals of economic importance. A notable series of such musical rocks are described from Makurapiti, near Mount Agnes on the border of South and Western Australia.

Small portable stone kondala also are used. A specimen of such from the Everard Ranges is described, and details are given of the part played by wooden kondala; both plain ones for secular use, and carved ones made for ceremonies associated with male initiation.

INTRODUCTION

In May 1957 the present writer, while on a visit to the Western Desert discovered that aborigines of the Pitjandjara tribe used musical sounds made by striking large rocks with hammerstones.

(1) Part I appeared in these Records, v. 13, 1959, pp. 305-332.

These bell-like tones represented the "voices" of ancestral totemic beings, at initiation and "increase" ceremonies.

Therefore it was with some interest he discovered, on his return from the expedition, that similar discoveries of "rock gongs" had been made in Africa and published by Fagg (1956, 1957). The observations in Africa and Australia were made quite independently of each other, and are not likely to be related in any way. More recent references to African rock gongs have been made by Lanning (1958), Robinson (1958), Conant (1960) and Vaughan (1962).

MUSICAL ROCKS AT MAKURAPITI

On 13 May 1957 we were examining the sandhill country around Mount Agnes in the Blyth Range near the border of South and Western Australia (129° 5′ E. Long. x 26° 50′ S. Lat.). The writer was in the company of Messrs. W. B. MacDougall and R. Macaulay, with two Pitjandjara aborigines, Peter and Willy. We had broken a new land-rover track across sandhill country from Mount Davies while in search of a family group of aborigines, strange to the Pitjandjara, who had been reported to have come into the area from the south-west. The signs of their presence had been of the nature of the smokes of distant fires.

Passing around the south-western extremity of the Blyth Range we came upon an ordered arrangement of stones, which our native companions said was the ceremonial place of Makurapiti, and used for the "increase" or "fattening" of the ['walkurari]. The phrase used by informants was "fattening the ['mako]".

Walkurari are the large, larvae ['mako], of several species of Cossid moths. One of them is *Xyleutes leucomochla* Turner 1915. These larvae live in silk-lined tubes about a foot underground and feed externally on the roots of wattle shrubs, including *Acacia Kempeana*, *A. victoriae* and *A. ligulata* (Leguminosae). A good harvest of the grubs is a matter of vital concern since they form an appreciable part of the diet, not only of young children but also of adults (Tindale 1953).

The ceremonial ground of Makurapiti is in a flat sandy area, with an underlying pediment of the rocks of the Blyth Range. The place is in a shallow basin some 80 feet long varying in width between 20 and 40 feet. The basin runs in a N.W. to S.E. direction, expanding at the southern end into a circular area with a diameter of some 40 feet.

The hollow evidently had been man made; debris repeatedly had been swept away to the margins so creating a shallow depression which formed the dancing area.

Near its northern end stood a single subrectangular erect stone block, two feet high, with a red and white painted figure on one face; the design was an inverted U-shape figure in white enclosing red (plate 25, fig. A). There was a vertical white line down the middle of the design on the stone. Beside this painted stone lay three smaller ones similar to native hammerstones. On one corner of the big stone and facing away from the painted design was a shallow cup-shaped depression about three inches across. This had been rather freshly battered into the rock and therefore showed up in marked contrast to the russet red colour of the weathered surface of the undecorated parts of the stone.

At the opposite end of the cleared area, in the centre of a circular expansion of it, was a complex arrangement of stones including as centre pieces two long semicylindrical stones, apparently the halves of a once still larger boulder, originally about nine feet long. This had fractured so that one half was about six feet long and the other somewhat shorter (three feet). The two halves either had moved apart or the space between had weathered so that there was a gap between them in which lay a cylindrical stone of smaller size with batter marks at one end. Other stones were piled on one side of the arrangement. In addition there were either thirteen or fourteen heaps of rounded stones arranged around in a circle at intervals of five to six feet, so that the central pile formed the hub of a large circle of stones.

The two main stones are shown in plate 25, fig. B. They had been painted with narrow vertical stripes forming alternatively red and white bands. As on the stone at the northern end there were fresh-looking shallow cup-shaped battered impressions on the ends of the big stones as well as on the smaller one lying between them. Some smaller rounded and subcylindrical stones with which the cups in the rocks had been made were lying nearby.

Our first reaction to the fresh-looking batter marks was that some vandal had mutilated these ceremonial objects. However we were several hundred miles removed from the haunts of such persons in virtually unexplored country and the native informants at once put our minds at ease. They indicated the marks were related to the ceremonial arrangement of stones, and demonstrated how they had been caused.

The large rocks were rock bells, musical stones, or rock gongs, the ['woŋka], "voices" or "talk" of ancestral beings; they were ['kondala], ['kondala 'bulka], ['japu 'kondala], or ['kondali] gongs, big gongs, rock gongs, or gongs.

Old man "Peter" showed us how ['mina] or blood from a pierced small vein in the arm had been allowed to run down the rocks during their decoration, the stream of blood being directed so as to form a red line between each white one. Red ochre was also used. The white paint was made by crushing the white parts of the dung of the Australian eagle. This yields an intense white colour which photographs well even when almost obliterated by time and weathering.

Of the pair of large stones at the southern end, the larger decorated stone was the ['walkurari mama] or ['walkururi] grub father, in his human aspect as an ancestral being, and the smaller one the ['nondjo] or mother. Other smaller stones represented their ['kata] or children. The heaps of stones at a distance represented other ['walkurari] people of the past. Plate 26, fig. A shows two battering marks on the end of the ['mama kondala] and at the left in the general photograph may be seen one of the striker stones as left by the users. The striker stones are subspherical hammers each weighing several pounds.

At the opposite end of the ground the single upright painted stone was the ['malu kondala] or ['kondalu] of the kangaroo, and had been placed there by the ['Wati 'Malu 'tjukur] or ancestral kangaroo man being.

The whole ceremonial ground gave the impression that it might have been intended as a gigantic representation of a Cossid larva ['mako 'witjuti], or witchety grub, but this may be a fanciful idea.

Fifty yards to the W.N.W. and forming part of the same sacred place was a large vertical rock slice some twelve feet long and probably weighing several tons, leaning against a larger mass and resting, with a blunt point downward on another rock. This was a gigantic ['kondala bulka] of the ['windaru], or desert bandicoot totem. Plate 26, fig. B shows a long pole-like white design which had been painted on it, with traces of red between. The red was human blood again from the arm vein of one of the owners of the site. The "voice" of the ['windaru] was evoked by striking at the base of the stone where the shallow cup-shaped battering mark is evident (plate 26, figs. B and C). With the informants' permission I tapped the big ['kondala] just as the ['windaru 'tjokoratja] being had first struck it and heard the clear bell-like note it gave out.

The ['windaru] or ['wendari tjukur] of Makurapiti was an ['inma 'bulka] or important ceremony and belonged to the ['tam:u] = ['tjamu], father's father of my informant. Peter spoke the words of the following songs which had come from his ['tam:u]:—

1. Song.	'Warta	'be:re	'be:re	'mina	'mina	'kanei:djara
	spear	hook	hook	arm	blood	flowed out(?)

2. Song. 'Koro:to 'pi:npa 'jararo 'wa:ni ja 'murturtu na

3. Song.	'Wanigi	'tjo:ko	t'jono	'mani	'bulka
	Thread cross	at totem place	came out	pole	large

In singing the last-named song the words were modified to—

3a. Song. 'Wanigi 'tjoka'bei 'tjoka'bei 'mani 'bulka

On the large rock, against which the ['kondala] rests are a few rock carving marks, principally single circles, concentric circles ['kurikuri], U-shaped marks, and a meandering lines of dots. These are ['wati 'mere 'walku], the "marks made by men now dead".

On the great flat rock above this ['kondala 'bulka] is a rounded flat stone, several feet across, on which a shallow groove is present; this groove may be natural, at least in part. According to Peter this stone received applications of blood and human semen. The mixture was rubbed all over it.

The whole stone ['kondala] appears to represent an ancient ceremonial pole called ['mani]; it is a ['ŋuru 'mani 'bulka], a phrase for which I could not get an exact meaning, and the vertical painted red and white design on it represents the central pole of a ['wanigi] (thread cross) of the ['windaru 'tjukur] or desert bandicoot totem. The painted marks were ['walka lamal kutu].

During the ceremony of the ['windaru tjukur] a large ['wanigi] made of ['puduru], fur-and human hair-strings, was set up and displayed to ['ulpuru] or youths about to undergo circumcision.

Kodachrome photographs were taken on 13 May and others of larger size in black and white were made early on the following morning.

Having examined country to the west of Mount Agnes and unsuccessfully searched for some aborigines of another tribe from the south-west, who had lately visited the area, we camped near Makurapiti for the night and much of the detail given above was told to us around the camp fire. Our Pitjandjara men, who had not visited this, the western limit of their country, for many years were indignant that strange aborigines had trespassed on their territory.

On the 14th, just before we left the area, our older informant, Peter, carefully cleared away all dead twigs, dry grass, *Salsola kali* bushes and other debris from around the large ['walkurari] arrangement of stones, paying particular attention to the groove between the two halves of the stone. He said the place belonged to his people and that keeping it clean was a proper attention, even though it had been some fifteen years or more since his own folk had been able to visit the area.

Not all of our informant's statements could be understood at the time, because some words were new or strange. In particular the full meaning of the word ['talundja] was not clear—it appears to relate to a place associated with the "increase" or, as Peter said it in English, "fattening" of food animals. Another phrase not clearly understood was ['Kudutupiti]. This may be a place name. The word ['piti] appears to relate to the hole, cave or other site where an ancestral being, having changed state remains today "inside the ground". ['Kudutu] we could not translate. We had already visited ['Kalaiapiti], an important place in the Sir Thomas Range (129° 47′ E. Long. x 27° 10′ S. Lat.), where the spirit of the great Emu ancestor of the Pitjandjara, ['Kalaia 'tjukur], still remains, living in a place so important that no-one may visit the actual spot, although initiated men, as we did, were permitted to approach the nearby spring and soak at ['Ilpi:liŋa] and were able to examine other secret objects, such as the painted rocks of ['Minma 'tjuni 'bulka], literally "big-bellied woman", associated with the ['Wati 'Kutjara], and with the ['Kuŋka'ruŋkara]. These are Beings who already have been referred to in Part I of this series of papers. Ilpilinga is a place where special rites were performed, in part by women. They were considered important in stimulating the onset of puberty and the growth of breasts in young Pitjandjara girls. A few details of these ceremonies will be given in a subsequent part of this series of papers.

In later discussions we learned that not only were there large static ['kondala] in many places, including ones near Kalaiapiti, but there were smaller, more portable stone ['kondala] in use in many places where large musical rocks were not available.

No opportunity came to examine one of the portable examples other than the casual observation of several smaller ones present at Makurapiti. However the indication that such smaller stone examples did exist was confirmed shortly after return to Adelaide when one was identified among specimens received recently at the South Australian

Museum. It had been collected by the late Capt. S. A. White. This specimen, labelled as from the Everard Ranges, presumably had been obtained during his visit to the Everards in 1914 when he spent some time among the Jaukundjara people, being the first white man to do so. During that stay he had as helper a young native whom he called "William", now an elderly man, with whom I talked during my 1957 visit. William showed me one of the rock shelters with paintings in it which White also had examined. Unfortunately this was before White's specimen became known to me and there is no mention of the stone in his writings. In the circumstances it is identified as a ['kondala] by inference only; I base my identification on the existence of the familiar battering marks and on the fact that when struck it emits the expected musical tones.

White (1916, p. 115) did witness, and describe a ceremonial dance which he called "Aboo-Warroo". In this performance three decorated men took part. This may be recognized as the ['Japu 'Waru], an ['inma 'laka] of the semi-secret type and related to several witnessed in 1933 and during later visits among the Jangkundjara. The name means "stone fire". In such a dance men prepare for the performance in a secret camp by bleeding one of their number, taking ['mina] blood from a vein in his arm and decorating their bodies with paint and blood. The mode of obtaining this blood is withheld from the knowledge of women as a great secret. On the other hand the blood obtained by stabbing the under side of the subincised urethral stem with a sharp stick is less secret. After dark the non-secret part of the performance takes place in the presence of women and children, who may take part also in the singing. They see the dancers by the light of stage fires of *Triodia* grass and brushwood set alight for the purpose. According to my informant it is in the background of such dances that ['kondala] may be struck. Since White made no mention of such a happening at the dance he witnessed it seems likely that the stone which came into his possession was a casual find, when aborigines were not about to indicate its function.

Fig. 1 and 2 show two views of the Everard Range specimen. This is now A51658 in the South Australian Museum collection. It is composed seemingly of an indurated sandstone or quartzite, and is in the form of an elongated pebble or small boulder. Its length is 47.5 cm. and it is flattish-oval in section with diameters respectively of 8.5 cm. and 6.0 cm.

The specimen probably originated as a waterworn boulder and was selected because it rang with a clear note when struck. There is

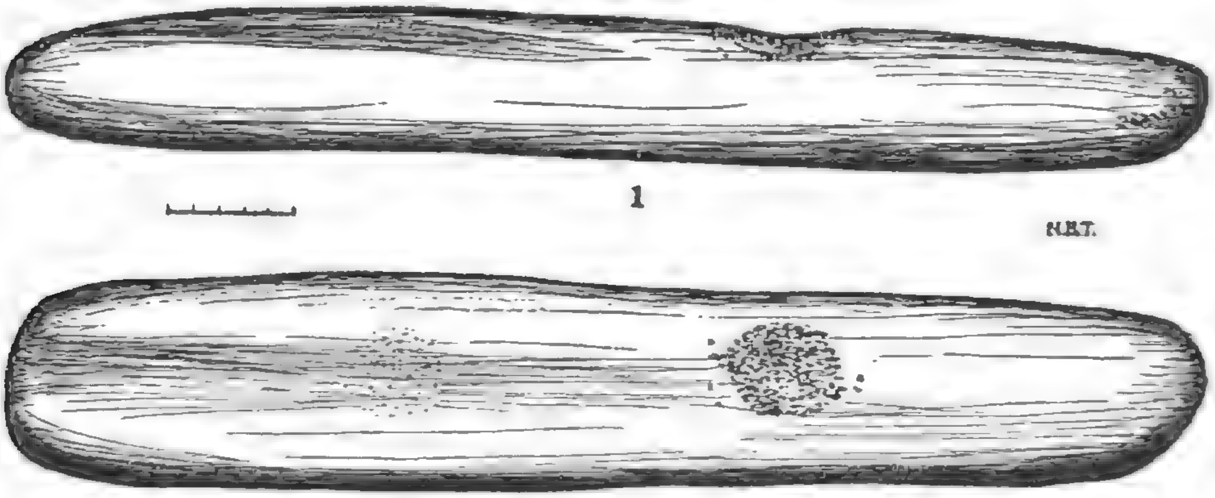


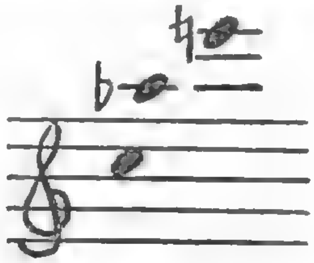
Fig. 1-2. Two views of supposed musical stone, kondala, from Everard Ranges, South Australia. Specimen A.51658 in S.A. Museum.
The scale in this and following drawings is to be read in centimeters.
(Collected by S. A. White.)

evidence for only a minimum of deliberate shaping. The two ends appear to have been trimmed by battering; some of this may be of natural origin. A shallow, slightly oblique groove on one face may be due to a natural softer layer in the stone but seems to have been abraded a little after it became a musical instrument.

The principal evidence for use takes the form of concentrated battering marks on one flat face, and other lesser marks which exist at the ends of both of the narrower faces. The last-named batterings, being fewer, suggest that the stone was not as often struck near the ends as on two areas on the upper flat face. At a point one-third from one end of the latter is a concentrated area of coarse batterings, which have developed into a shallow cupped depression. When struck at this point the stone emits a clear musical tone. At a point one-third of the distance from the other end is a similar area, occupied by very much more delicate batterings and the surface of the stone here has a high degree of polish on it.

The fundamental note emitted when the stone is struck has been identified for me by a musician as C. Higher notes are A flat and E sharp.

By comparison with bruise marks on known larger [ˈjapu ˈkondala] it seems evident that the coarser batterings were made by using another stone as striker. It seems equally plausible to suggest that the more delicate batterings at the other end were made with a hardwood striker. The effects could have been produced by tapping



sticks of the kind which have a ball of resin on one end. Experiments show that the batterings are focussed on the several places on the stone where tapping will evoke the purest and best ringing tones and that a wooden striker works best on the place where the delicate bruising is most evident.

My conversations with Peter and Willy during other days of our association served to augment observations I had made in 1933 about two types of decorated wooden sticks, both of which are called

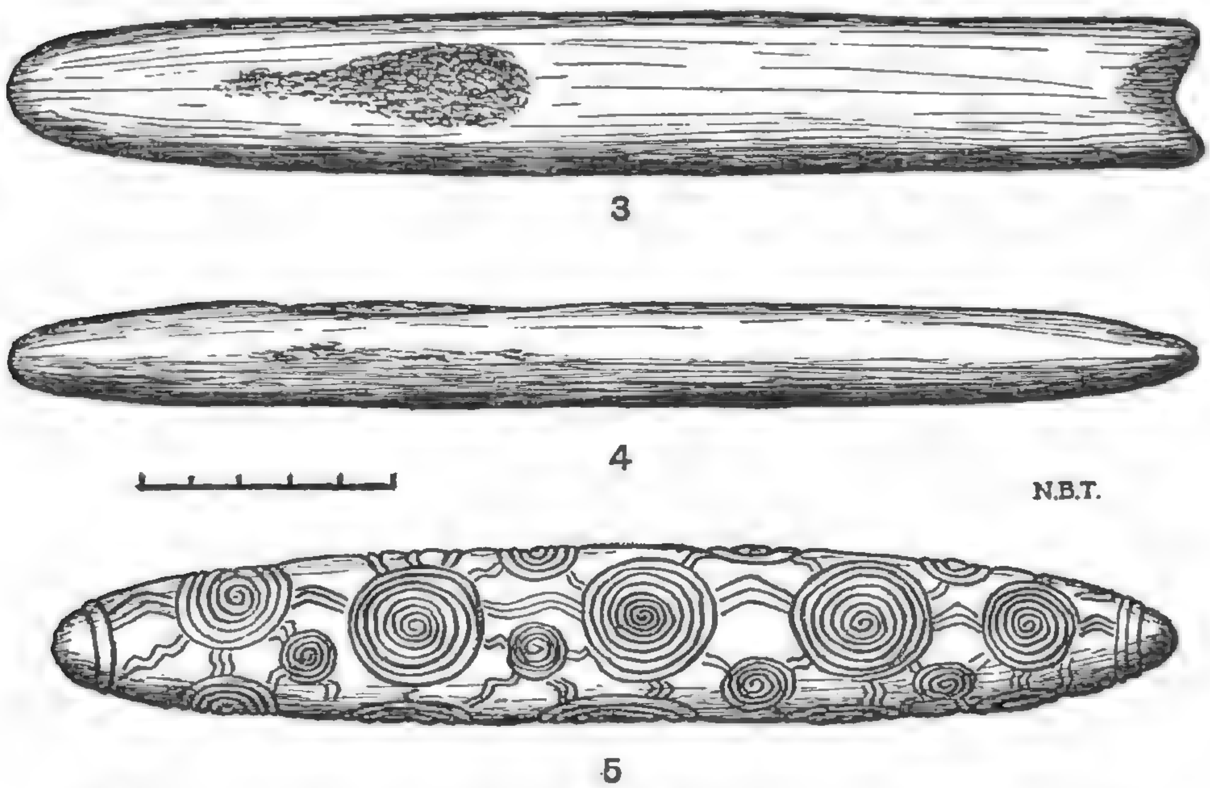


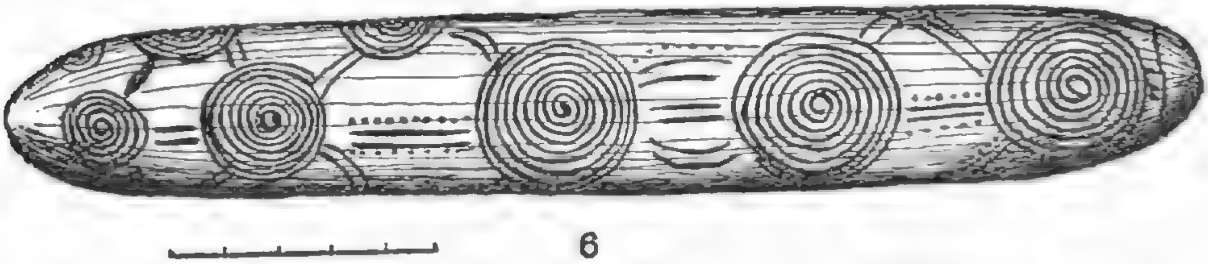
Fig. 3-5. 3-4. Two views of tapping stick, South Central Australia (A.21577). 5. Ceremonial kondala of cylindrical type, W. Australia (A.50022).

['kondala] or ['bunu 'kondala], *i.e.*, "wooden kondala", and used in ceremonies which precede the Pitjandjara initiation rites witnessed in 1933 at Konapandi (Tindale 1934). I also saw similar ones among the Ngadadjara tribespeople at Warupuju, in the Warburton Ranges, Western Australia, in 1935. Some details of the ceremonies at which they were used are published in the form of 16 mm. motion picture films by the Board for Anthropological Research, University of Adelaide (film Nos. 20, 26-28, and 38-39).

At Konapandi on 22 June 1933 the elderly ['maijada] or leading old man of the Pitjandjara initiation ceremonies then being held, whose name was ['Tgarŋga], gave me three carved music sticks of cylindrical form; these he called ['kondala] (fig. 6-8). The specimens, A21648-21650, are now in the South Australian Museum. They functioned as musical sticks at an ['inma 'laka 'tiŋari], or secret ceremony seen only by initiated men. This ceremony was known as an ['inma 'kondala]. The men present had not made these particular examples which had been passed along from people living west of Peltadi in the Mann Range. The song which was sung when they were struck was:—

Song. 'Kondala 'meil 'meil 'waŋganda
Music sticks meil meil make talk

The term ['meilmeilba] can mean secret or sacred, and is applied to anything which must not be known to women and children. At this time the full significance of these ['kondala] was not apparent, but during the progress of the ['Puruka] ceremonies which we then witnessed (Tindale 1934), at which men ritually broke avoidance rules, several men spent time decorating further tapping or musical sticks, this time making them very much like wooden hair pins, each with a ball of resin at one end but of wood which rings when struck, whereas hairpins are often of non-resonant wood. The designs they placed on these ['inma 'kondala] were patiently burned into the wood by applying and gently blowing a glowing twig. Terminal rings, burned near the pointed end of these sticks, were considered to be of particular importance because of the circumcision rites which were about to take place. Several of the examples made on the occasion are now present as A21652-21654 in the South Australian Museum collection and one A21653 has been depicted (fig. 9). Each has a ball of *Triodia* resin at one end. In addition to their function as musical sticks they may serve also as hair pins or head scratchers, being part of the elaborate coiffure with chignon foundation which is worn by young initiated men when in full dress. An example of the more normal wooden pin of the Pitjandjara men is shown as fig. 11. It was made at Pital, a place on the plain between the Mann and Musgrave Ranges, by a man who had taken part in the initiation ceremonies at Konapandi only a day or so earlier. The burning of such a design is shown in Reel 3 of 'Day in the Life of Pitjandjara natives' by N. B. Tindale, 1933.



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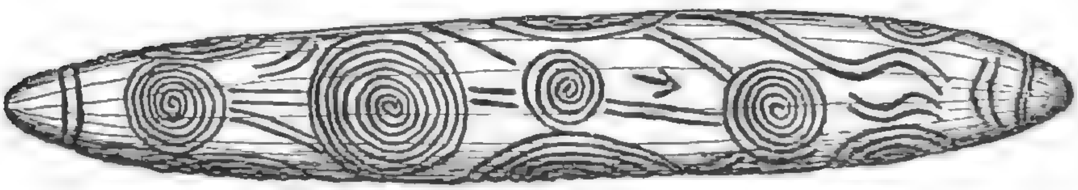

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Fig. 6-7. Two wooden kondala from Peltadi, Mann Ranges, South Australia, used in initiation ceremonies at Konapandi (A.21648-A.21649).

The cylindrical wooden ['kondala] bear rings carved on them, usually at both ends. It was learned that the number of carved rings may correspond to the number of young initiates who are to be circumcised at the initiation ceremony for which they were made. They also may be sent out as message sticks. The specimen illustrated in fig. 5 very closely resembles the type used among the Ngadadjara. It can be interpreted to tell us that the ['tjindulakalŋuru] people, those who "sit in the sun", might provide three youths, while the ['wiltjalaŋuru], the people of the other generation, those who "sit in the shade" would be providing two for the coming rites. During the 1935 circumcisional ceremonies seen at Warupuju, cylindrical wooden musical sticks had been specially carved for the occasion, the designs on them being incised by means of an engraver made from the lower jaw of an opossum. The long incisor tooth with its tip broken off served as a burin. These music sticks, called ['kondala] and ['kundala] by the Ngadadjara, were used as time beaters in the singing associated with the showing of ['inma] or secret objects to the ['maliki] or initiates. At this time special marks called ['wa:li] were painted on the chests of the ['maliki]. There is probably much more to be learned about these wooden ['kondala] and their association with the stone ones.

Fig. 8-9. Fig. 8. Wooden kondala from Peltadi used in initiation ceremonies at Konapandi (A.21650). Fig. 9. Hairpin made during Puruka ceremony at Konapandi (A.21653).

To round out this report on ['kondala] it should be noted briefly that wooden musical sticks, or tapping sticks, also called time beaters, are used at evening dances in many parts of Australia, and are of varied form. There are many published references to them. In some areas such as coastal Arnhem Land, where the boomerang is unknown as a weapon, they may be made from pairs of traded Central Australian hunting boomerangs; the surface of the wood on these may be so worn, by generations of use as time beaters, that the original fluted design is only made evident by holding them against the light.

Specially made tapping sticks are fashioned from particular hard woods which ring when struck. Some have prolongations at one end like the arms of a tuning fork. Fig. 3 and 4 show two views of a typical example of ones in secular use from South-Central Australia. It was collected by the late Dr. Herbert Basedow and bears a partly illegible india ink label which appears to read " . . . S.A. 1904" but the beginning is lost and the last figure of the year date could be read almost equally well as an 8 (specimen A21577 in South Australian Museum). The style suggests that this example originally had been traded down from further north in Central Australia. Pitjandjara ones of hardwood, with a ball of resin at one end, and used in ceremonies, have already been mentioned.

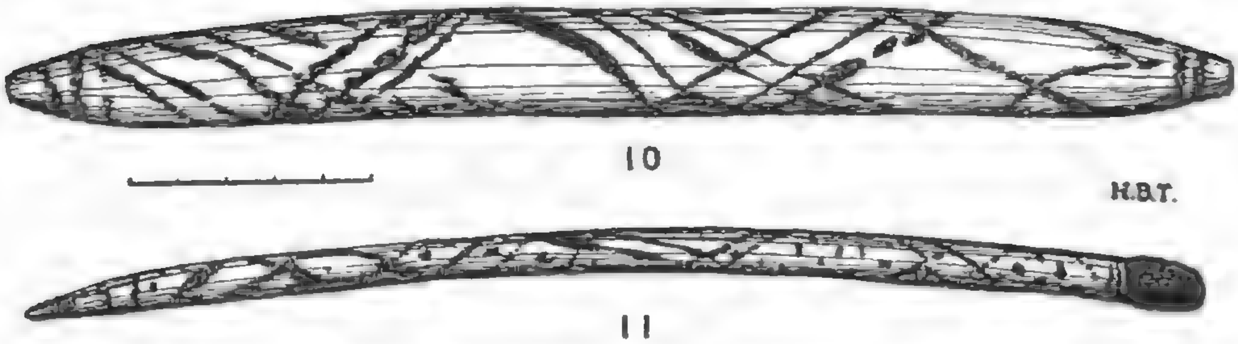

Fig. 10-11. Fig. 10. Wooden kondala, Ernabella, Musgrave Ranges, South Australia (A.21667). Fig. 11. Wooden hairpin for young adult male Pitjandjara coiffure; made at Pital, between Mann and Musgrave Ranges, South Australia (A.21655).

DISCUSSION

Pitjandjara nomenclature classes all objects for evoking musical sounds, whether of stone or wood, as [ˈkondala]. When it is necessary to differentiate, stone ones are [ˈjapu ˈkondala] and wooden ones are [ˈbunu ˈkondala]. Nomenclatorially the question of portability is not significant. Large static ones are [ˈjapu ˈbulka ˈkondala], "stone big musical" or [ˈkondala ˈbulka].

Archaeologists may not be satisfied with this degree of differentiation. For their benefit I propose that the term *kondala* should apply to archaeological stone examples, many of which will undoubtedly be found in the future. Archaeological wooden ones, being less likely to be found may be known as *bunu kondala*. I nominate the example described and figured herein, from the Everard Ranges as a typical *kondala*. Large static ones which will also be discovered may be classed as *kondalabulka*.

It is frequently noticed that there is a strong tendency for words associated with related objects and ideas to occur in widely separated parts of Australia, permitting the assumption there is an old element in common over large areas. The term [ˈkondala] is no exception. Attention may be drawn to the following casually noted examples:—

In the Western Desert a [ˈkondala] is a stone or rock struck for musical purposes, also a musical stick. The Ngadadjara term varies as [ˈkundala]. Among the Darumbal of Rockhampton, Queensland, *kundala* is an upper stone of a pair for pounding particular foods (Roth, 1904, p. 23).

In the vocabulary of the Pangkala natives of the country south-west of Port Augusta there is a phrase *walgi kundatanna* about which little is remembered except that it relates to a "mysterious song"; their verb *kundata* means *to beat* or *to strike* and the noun *walki* is applied to "something hard, swollen, or of rounded shape". Is it possible to link this with the idea of a musical stone? Archaeologists should note this possibility. It does draw attention to how little we really know about our aborigines and points up the fact that we may yet be able to learn something if all sources of primary information on the living are gleaned and exploited before it becomes too late.

In Africa the rock gong complex is linked with rainmaking (Lanning 1958), also with initiation into manhood, and there may be rock paintings associated with the gongs. Fagg (1957) considers that rock slides also may be an associated feature. In Australia musical rocks are associated with initiation and with "increase" ceremonies, of which one type at least is linked with the "increase" of rain. Despite these similarities it is unlikely that there is any direct connection between the practices of the two areas.

From earliest times men everywhere have been concerned with initiations, and with the betterment of their circumstances by performance of magical rites using song, dance, rhythm, and paint. Therefore it is not surprising that parallel customs and ideas may have arisen in places as far sundered as Africa and Australia.

ACKNOWLEDGMENTS

The writer is indebted to the authorities of the Long Range Weapons Establishment for permission to accompany their field officers, Messrs. W. B. MacDougall and R. Macaulay on patrols into the Western Desert, and to the Range Superintendent and these officers for their unstinting aid.

Mrs. C. J. Ellis kindly identified the musical sounds emitted by the Everard Range ['kondala] stone when struck.

Earlier portions of the work was done as leader of two Board for Anthropological Research Expeditions, one to the Mann Range, South Australia in 1933 and the other to the Warburton Ranges, Western Australia, in 1935. Both these expeditions were supported by grants from the Rockefeller Foundation, the University of Adelaide and the South Australian Museum.

The present paper owes much to discussions with my colleagues, in particular with the Hon. Associate in Anthropology at this Museum, Mr. H. M. Cooper. The opinions expressed and any shortcomings in presentation are the author's own.

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EXPLANATIONS OF PLATES 25-26

PLATE 25

Fig. A. ['Kondala] musical stone of the ['Wati 'Malu 'tjukur] at north-western end of ceremonial ground of the ['walkurari] totem, Makurapiti, eastern end of Mount Agnes, Blyth Range, showing the face of the upright stone with the inverted U design and the median vertical line; note the battered corner at the right.

Fig. B. ['Mama 'kondala] (left) and ['ngondjo kondala] stones of the ['walkurari] grub totem at the south-eastern end of the Makurapiti ceremonial ground; the painted stripes are evident; in the background may be seen two of the many heaps of smaller stones. (Photos., 14 May 1957, by Norman B. Tindale.)

PLATE 26

Fig. A. Close view of two battered places on the ['mama 'kondala] stone of the Walkurari totem, showing also some detail of the decoration of red blood and white eagle dung paint.

Fig. B. The giant musical ['kondala] of the desert bandicoot ['windaru 'tjukur], with the painted vertical ['mani] design; the striking place is near the base.

Fig. C. Close view of the cup-shaped battering place on the giant ['kondala] of the ['windaru 'tukur] at Makurapiti. (Photos. 14 May 1957, by Norman B. Tindale.)


A


B


B
A
C

PRELIMINARY SURVEY OF THE ABORIGINAL RENIFORM SLATE SCRAPERS OF SOUTH AUSTRALIA

BY ROBERT EDWARDS

Summary

This paper places on record the results of an examination of 226 slate scrapers.
The literature has been reviewed; typical forms of the implement described and figured, and their manufacture discussed.
The preliminary survey shows that the implements appear to have had a limited South Australian distribution and to have been used exclusively to scrape skins when preparing them for making rugs and cloaks. Some scrapers are decorated with surface markings and in a few cases they are the only surviving art forms of the aboriginals of the area in which they were found.

PRELIMINARY SURVEY OF THE ABORIGINAL RENIFORM SLATE SCRAPERS OF SOUTH AUSTRALIA

By ROBERT EDWARDS

Plates 27-29 and text fig. 1

SUMMARY

This paper places on record the results of an examination of 226 slate scrapers.

The literature has been reviewed; typical forms of the implement described and figured, and their manufacture discussed.

The preliminary survey shows that the implements appear to have had a limited South Australian distribution and to have been used exclusively to scrape skins when preparing them for making rugs and cloaks. Some scrapers are decorated with surface markings and in a few cases they are the only surviving art forms of the aboriginals of the area in which they were found.

INTRODUCTION

For many years various investigators have been collecting reniform or kidney-shaped stone implements from abandoned aboriginal camp-sites in many localities in South Australia (map, fig. 1). Each specimen found has increased our knowledge of these implements and widened the area of their known distribution. The collection now available is considered sufficient to enable the writer to make a preliminary survey.

Campbell (1924), Basedow (1925), Hossfeld (1926), Howchin (1934), McCarthy (1946) and Cooper (1959) have described and figured some of these implements and their findings will be considered with the additional knowledge gained from the survey of this considerably larger collection of specimens than was hitherto available.

Basedow (1925, pp. 173-176) described the implement as a skin scraper and from observations of its general form it seems reasonable to assume that it was so used, although no published record exists of any person actually seeing one in use.

TYPICAL FORM

A typical example of this slate implement is reniform in shape (plate 1, A and B) with an average length of 11 cm., 7 cm. in width and 0.7 cm. in thickness. The concavity of the reniform outline is reduced to a relatively thin margin to form the functional edge of the implement. Its size is such that it can be conveniently held in the hand and is sufficiently robust to provide support for the thin working margin when in use.

Measurements of the illustrated specimens are given at the end of this paper.

MATERIAL EXAMINED

This investigation revealed that at least 260 reniform slate scrapers have been found in South Australia and of this number it has been possible to examine 226 specimens; most of these are in the collection of the South Australian Museum, the remainder being in the possession of private individuals, including the author. The only specimens not available for this investigation are either in interstate collections or otherwise dispersed. These are 34 in number, but the localities where they were found have been recorded as South Australian by Basedow (1925, p. 173); Hossfeld (1926, p. 291); Howchin (1934, p. 79) and Tindale[1].

CLASSIFICATION

The 226 slate scrapers which comprise this survey vary widely in shape, size and thickness according to the particular quality of the material used (plate 29, A to H).

The various shapes can be tentatively classified into four groups. Eighty-three have a typical reniform outline (plate 27, A and B); thirty-eight are rounded, having almost the same width as length (plate 27, C and D); 18 are elongate, the length being approximately twice the width (plate 27, E and F), and 48 are of varied, irregular shape.

Many of the specimens examined were found to be damaged and only a small proportion have survived in perfect condition. Thirty-nine are recognizable fragments which are too small to allow even tentative classification.

(1) Mr. N. B. Tindale provided extracts from his unpublished journals on "Camp-sites and Implements" (vol. 1-3, 1940-1961) which refer to scraper finds.

It seems likely that this particular implement existed in greater numbers than present collections from camp-sites would indicate. The fragile material from which they were made makes them liable to damage by stock movement and other factors. Only by increased knowledge can the recognition and recovery of fragmentary specimens be effected.

DISTRIBUTION

Although Hossfeld (1926, p. 291) placed on record P. deS. Stapleton's discovery of four reniform slate implements near the Patawalonga Creek in 1898, the first specimens actually recorded were found by Campbell (1924, pp. 74-78) at Moana, south of Adelaide, where a large camp-site is situated in an area of red sand-hills near the mouth of Pedler Creek. Extensive field work, carried out upon this camp-site over a long period, has yielded a comprehensive series of stone implements.

Basedow (1925, pp. 173-175) found 19 scrapers at Normanville, two at Woodville and suggested a distribution restricted to the tribes which originally occupied the area between Adelaide and the River Murray. Hossfeld (1926, pp. 287-297) extended the distribution to the Eden Valley and Angaston districts by finding a number of reniform implements when studying previous native occupation of that area. Thirty-nine specimens have been recovered from camp-sites in those districts.

The formation of the Anthropological Society of South Australia in 1925 gave added stimulus to collecting and studying local aboriginal relics. At a meeting of the Society in March 1927 Stapleton exhibited a slate scraper collected from a camp-site near Hookina Siding in the Flinders Ranges[(2)]. This specimen (plate 29, C) appears to be the first recorded from northern South Australia and was an early indication of the wider distribution now accepted after the collection of many additional specimens.

From 1927 until 1934, when Howchin (1934, pp. 79-82) reviewed the subject, a number of scrapers were added to the collection of the South Australian Museum[(3)] by T. D. Campbell, N. B. Tindale, H. L. Sheard and P. deS. Stapleton. These scrapers had been found on the Adelaide Plains and in the Angaston District. This area Howchin defined as the limit of their distribution.

(2) Minutes of the Anthropological Society of South Australia 1926-1929.

(3) Register of the South Australian Museum.

McCarthy (1946, pp. 56-57) described the reniform slate implement as a specialized type of reniform scraper-knife and reiterated the general opinion that its distribution appeared to be limited to the Adelaide Plains. It is only since detailed field-work has progressed that the number of sites where they have been found and their spread has greatly increased. These finds have made possible the preparation of a map (fig. 1) co-ordinating all the known slate scraper localities. This map shows a far wider range of distribution than that recorded by Howchin.

MATERIAL USED

In the choice of suitable materials for the manufacture of his slate scrapers, the aboriginal showed his intimate knowledge of the qualities and texture of stone necessary for the successful production of his implements.

Most of the specimens examined are made from fine grained rocks such as siltstones, shales, phyllites and all the rocks commonly grouped under the term, slates. Besides being readily available, these rocks were admirably suited for producing reniform skin scrapers. In the case of shale it splits easily along its bedding planes into thin, regular layers, while slate separates in a similar manner, along its distinct cleavage planes. Once obtained, these thin, flat slabs were of convenient proportions to be fashioned into implements of desired shape and size while still retaining sufficient strength for practical use. When slate was not available, either locally or by trade, mica schist and occasionally gritty quartzite were used, but as these materials were not so suitable, the resultant implements were crude and unshapely compared with the typical reniform slate specimens.

MANUFACTURE

There is no published record of anyone having observed the manufacture of a slate scraper, but the procedure seems fairly obvious from the implements themselves. The author has a piece of slate from a camp-site at Edeowie, east of Lake Torrens, which had been roughly shaped to a reniform outline. The entire peripheral margin, including the concavity, appears to have been shaped by percussion with a light hammerstone. Most of the specimens examined for this survey still retain evidence of the removal of small flakes from the edges of their rounded sides.

It seems likely, therefore, that the entire edge of the implement was shaped at the same time until the desired reniform outline had

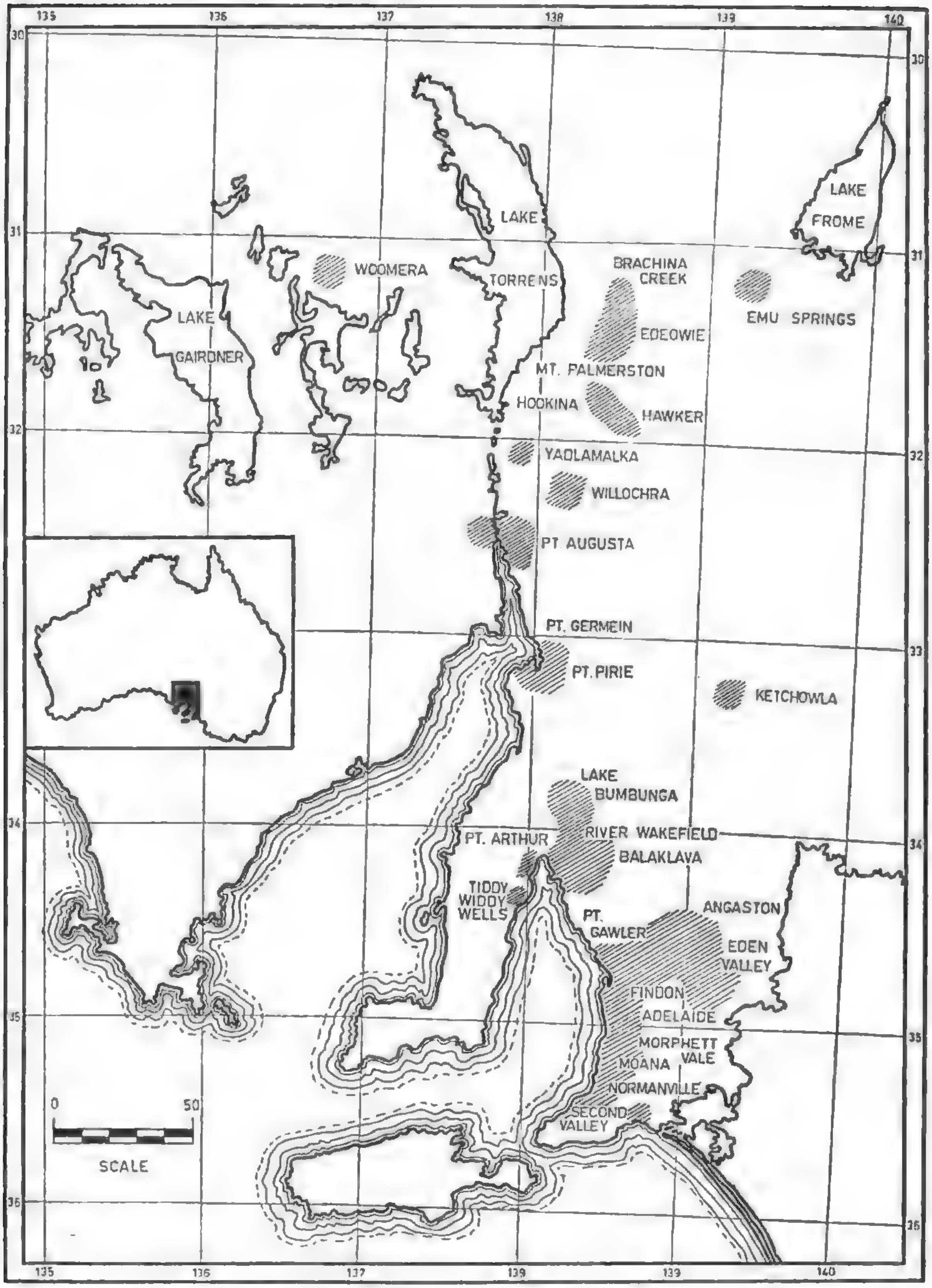

Fig. 1. Distribution of slate scrapers in South Australia.

been achieved. The concavity, after having been roughly shaped, appears to have been reduced by a rasping or rubbing action with some harder material to form a relatively thin, functional edge. Evidence of this smoothing down is indicated by the marks left on the flat surfaces of the implement. Some scrapers (plate 27, A and B) have had the entire peripheral margin finished in this way, so removing traces of the original trimming.

Cooper (1959, pp. 55-60, plates 4, 20 and 21), who has been largely responsible for extending the area of distribution of slate scrapers, suggests that many small pieces of slate, variable in shape, which he has found on a camp-site at Hallett Cove, show evidence of wear suggestive of skin scraping, and may be early equivalents of the slate scrapers described in this paper.

INCISED MARKINGS

As already shown, many of the incised markings on slate scrapers were obviously due to the method of fabrication of the implement. Other deeper markings however appear to have a deliberate purpose. These could be simple decorations or have some totemic significance.

It was the deliberate incised markings on the first specimens found by Campbell (1924, pp. 75-76) that led him to suggest they might be a simple form of tjurunga and Howchin (1934, p. 82) to suppose they were a "charm". These suggestions were not unreasonable as some years ago the author placed a similar interpretation on a number of small pieces of heavily incised slate which have since been recognized as definite portions of slate scrapers. At the time of their recovery on a camp-site discovered by Cooper at Willochra, far beyond the then accepted area of distribution of slate scrapers, the explanation that they were portions of some sacred object seemed a likely one.

A comparative study of the collection of slate scrapers now available showed that, while over 60 per cent have surface striations, only 10 per cent or 22 specimens appear to have a definite pattern formed from straight lines of varying length and degree of complication; some others suggest dog and emu tracks. Plate 28, A to F, illustrates both surfaces of three of the best examples of deliberate surface markings on slate scrapers. It is possible that the incised markings on other specimens could have been obliterated by weathering.

Cooper (1947, pp. 292-298 and 1954, pp. 97-103) has recorded small, flat, water-worn pebbles from northern and north-eastern South

Australia bearing somewhat similar markings to those found on slate scrapers. In the case of Cooper's finds, however, the incised markings have a regular pattern formed by a series of more or less parallel straight lines. The origin and meaning of these markings is unknown.

USE

Basedow (1925, p. 176) was the only person to describe and illustrate reniform slate implements as skin scrapers. Although he gives the following detailed account of their use to scrape fat and fleshy tissue from opossum skins whilst preparing them for making rugs and cloaks, this was not a personal observation. His informant was an old aboriginal of the "River Murray" tribe whom he considered reliable.

> "The freshly removed skin was laid, fur downward, over a cylindrical rod and drawn tightly around it with the fingers of the left hand. The implement was then gripped by the opposite hand in such a way that the convex edge was against the palm and the flat surfaces between the fingers and thumb. Holding the rod in a vertical position, the concave (or straight) cutting edge was placed against the skin over the rod and worked at an angle downwards, the cutting edge shaving off all adherent pieces of fat and other soft tissue in doing so. The position of the skin, relative to the rod, was frequently changed and the process continued until the whole inner surface of the pelt had been prepared and cleaned in a similar way.
>
> "The advantage of a concave cutting edge obviously was that by an accommodation of the two curves, presented by the implement and the rod, respectively, a greater area of skin was scraped with every downward movement of the hand; and the process was performed without so much risk of cutting the skin as would have been the case with the ordinary convex or straight-edged stone scraper or a plane surface."

DISCUSSION

Mountford (1960, pp. 505-508, 1963, pp. 525-543) has shown that the Australian aboriginals, over a wide area of southern Australia, employed a number of different methods in dressing skins of animals for making rugs and cloaks. Mountford describes and illustrates (1963, plate 33, C), a large stone flake being used for this purpose in the Northern Flinders Ranges. This is outside the area of known distribution of reniform slate scrapers. Schürmann (1879, p. 210) describes how the aboriginals of the Port Lincoln Tribe, South Australia, gently pulled or shaved off fleshy substances adhering to skins, with a sharp-edged piece of quartz. In the south-east of Australia, Howitt (1904, p. 742) records that skins were not dressed but merely dried and made pliable by cutting marks on them with mussel shells.

As far as the present investigation shows, the occurrence of slate scrapers appears to have been somewhat circumscribed and limited to the central area of South Australia, its southern and eastern boundary being the River Murray, and its northern approximately at Lat. 31° South (map, fig. 1).

A description, recorded in Adelaide in 1842[(4)], of the manner in which skins were prepared for making garments, shows that the large, coarse skins had their inner layers shaved off with a digging stick, club or the handle on which stone adzes were mounted, while the smaller ones were rubbed slightly with stones to make them loose and flexible.

It is suggested that the reniform slate implements were specially designed and ideally suited for scraping the smaller and more delicate skins, such as those of the opossum. The smooth, relatively soft, use-polished functional edge enabled them to be scraped effectively without damage.

Flanagan (1888, pp. 56-58) states that the Australian aboriginal, when making his rugs and cloaks, his only articles of clothing, showed a very distinct preference for the skin of the opossum because it was of superior quality for his particular purpose. If this is so and the reniform slate scrapers were, as has been suggested, a specialized implement for scraping these delicate skins, this may indicate that the number and area of their distribution has some relation to the production of these garments in those areas.

In the design, choice of material, manufacture and use of reniform scraping implements the aboriginal again illustrated his skill and craftsmanship in the art of converting simple, basic materials into efficient tools.

A purpose of this paper is to give an account of this interesting implement so that it will be correctly classified among the implements of the Australian aboriginals. It is also hoped it will encourage their

(4) Transactions of the Statistical Society published in *South Australian News,* 15 October, 1842, p. 46.

collection, so enabling a more comprehensive survey to be made and the area of distribution further defined.

ACKNOWLEDGMENTS

The author wishes to express appreciation to the following:—

The Board of the South Australian Museum for permission to work on the Museum Collection and for publication of this paper.

Mr. Norman B. Tindale, Curator of Anthropology of the Museum, who expedited the examination of the collection and supplied extracts from his personal journals which contributed greatly to the completion of the distribution map.

Drs. P. S. Hossfeld and W. I. North; Messrs. R. D. J. Weathersbee and R. E. Teusner made their private collections of slate scrapers available for examination.

Special acknowledgment is made to Dr. T. D. Campbell, Messrs. C. P. Mountford and H. M. Cooper, all of whom gave assistance by supervising the preparation of this paper. Mr. Mountford also helped with the illustrations.

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DESCRIPTIONS OF PLATES 27-29

PLATE 27

A-B. Slate scraper. Paradise, South Australia, K. S. Parsons, collector, length 10.8 cm., breadth measured from notch, 6.7 cm., specimen Reg. No. A.42813 in S. Austr. Museum.

C-D. *ditto.* Brachina Creek, S. Austr., D. N. George, length 9.8 cm., breadth 9.0 cm., A.30685.

E-F. *ditto.* Paradise, S. Austr., K. S. Parsons, length 11.5 cm., breadth 5.5. cm., A.48090.

PLATE 28

A-B. Slate scraper. Findon, S. Austr., E. J. Copley, length 12.0 cm., breadth 6.0 cm., A.21339.

C-D. *ditto.* Paradise, S. Austr., K. S. Parsons, length 11.2 cm., breadth 7.5 cm., A.42814.

E-F. *ditto.* Findon, S. Austr., E. J. Copley, length 11.8 cm., breadth 6.3 cm., A.21340.

PLATE 29

A. Slate scraper. Jutland, S. Austr., N. B. Tindale, length 10.4 cm., breadth 6.3 cm., A.28972.

B. *ditto.* Christies Beach, S. Austr., N. B. Tindale, length 12.0 cm., breadth 6.5 cm., A.28898.

C. *ditto.* Hookina, S. Austr., P. Stapleton, length 7.2 cm., breadth 6.6 cm., A.21311.

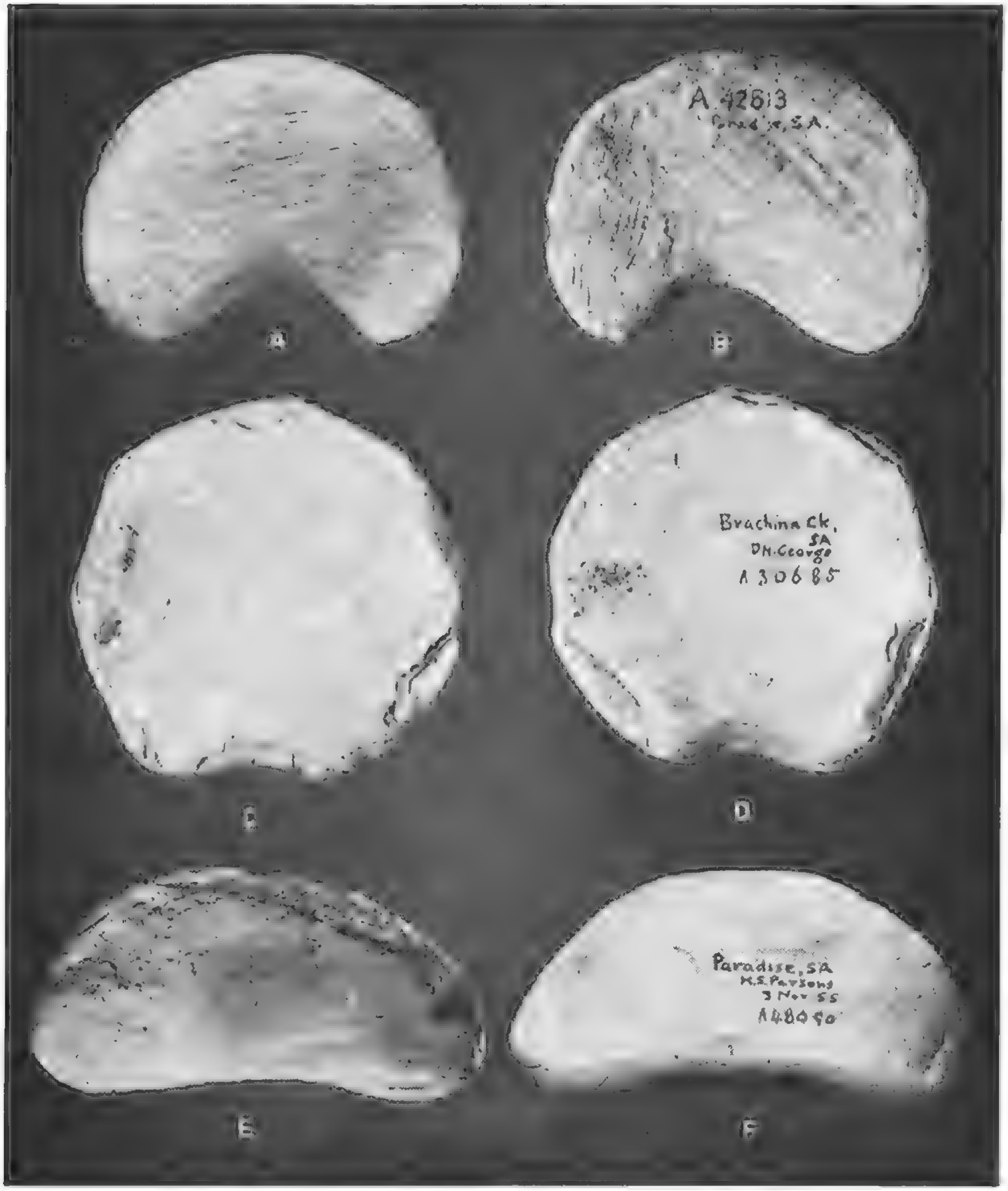
D. *ditto.* Sandy Creek, S. Austr., Adelaide Bushwalkers, length 11.0 cm., breadth 7.5 cm., A.36622.

E. *ditto.* Port Augusta, S. Austr., H. K. Bartlett, length 9.2 cm., breadth 6.7 cm., A.52925.

F. *ditto.* Brachina Creek, S. Austr., D. N. George, length 9.8 cm., breadth 7.3 cm., A.30686.

G. *ditto.* Glenelg, S. Austr., P. Stapleton, length 12.0 cm., breadth 6.9 cm., A.17326.

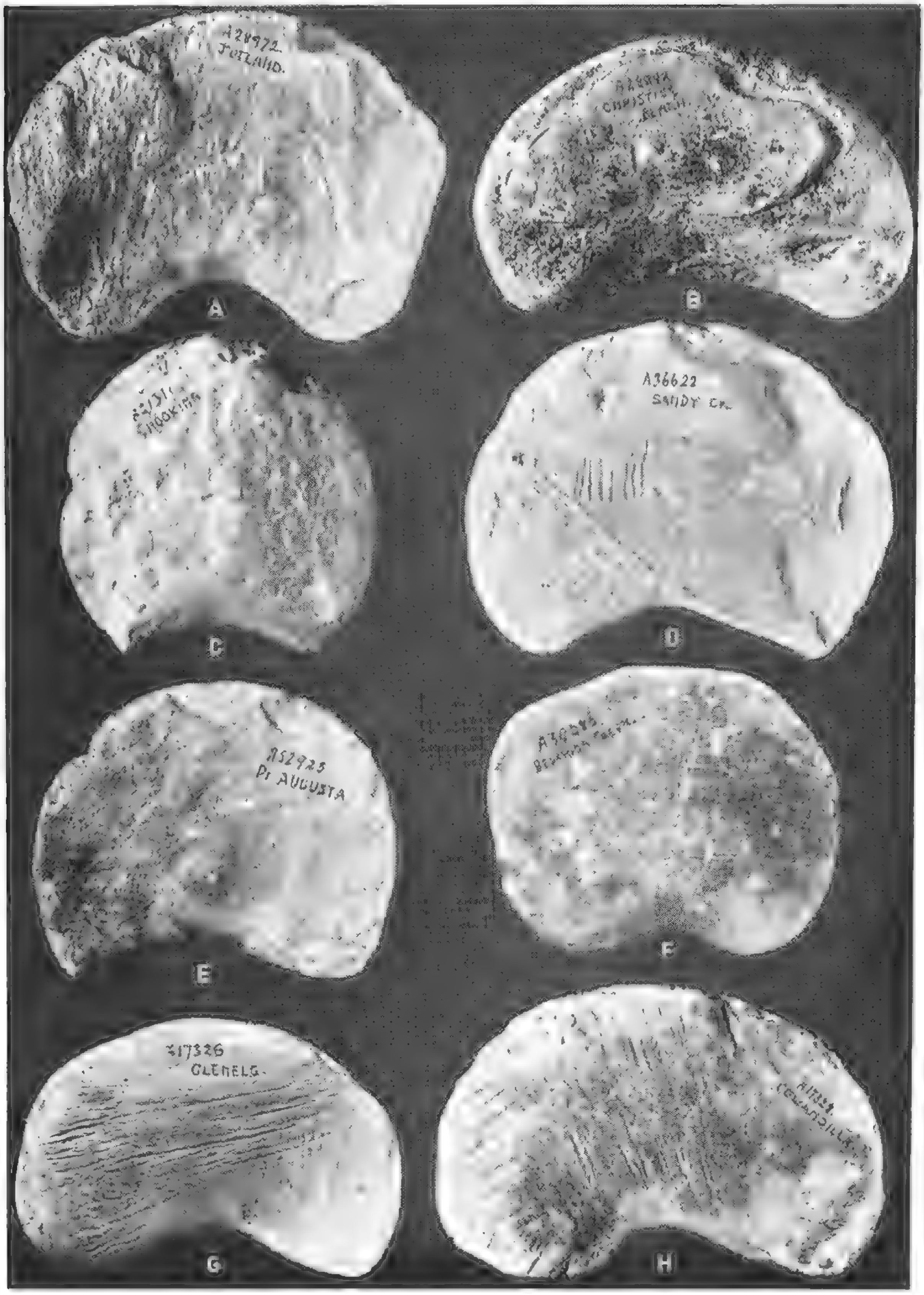
H. *ditto.* Cowandilla, S. Austr., P. Stapleton, length 13.0 cm., breadth 7.3 cm., A.17328.



A-B Reniform. C-D Rounded. E-F Elongate.
Slate Scrapers—Typical Forms.

To face page 324.]

Slate Scrapers—Examples of Surface Markings.



Slate Scrapers—Typical Forms and Variations.

AUSTRALIAN ABORIGINAL SKIN RUGS

By Charles P. Mountford, Honorary Associate in Ethnology, South Australian Museum

Summary

When the first Europeans visited the southern parts of Australia, they found both the Tasmanian and the mainland aborigines wearing capes or rugs made from the skins of the indigeneous creatures.

Although, in those early days, there would have been many thousands of those rugs in use, few have survived the ravages of time. Two main factors are responsible for this; the fact that, at death, everything belonging to the deceased, including his skin rug, was buried with him (Howitt, 1845, p. 189) ; and that, during those boisterous days of colonization, there were no institutions equipped, even if they were interested, in preserving those highly perishable examples of aboriginal handicrafts.

AUSTRALIAN ABORIGINAL SKIN RUGS

By CHARLES P. MOUNTFORD, Honorary Associate in Ethnology, South Australian Museum

Plates 30-33 and text fig. 1-5

INTRODUCTION

When the first Europeans visited the southern parts of Australia, they found both the Tasmanian and the mainland aborigines wearing capes or rugs made from the skins of the indigeneous creatures.

Although, in those early days, there would have been many thousands of those rugs in use, few have survived the ravages of time. Two main factors are responsible for this; the fact that, at death, everything belonging to the deceased, including his skin rug, was buried with him (Howitt, 1845, p. 189); and that, during those boisterous days of colonization, there were no institutions equipped, even if they were interested, in preserving those highly perishable examples of aboriginal handicrafts.

As far as can be ascertained, there are only seven rugs and two decorated skins in existence. There are two complete rugs and a single decorated skin in the National Museum of Victoria, two rugs in the South Australian Museum, a complete rug in the Smithsonian Institution of Washington D.C., another in the Western Australian Museum, a badly damaged rug in Berlin and a single decorated skin in the British Museum.

As it seems unlikely that many additional examples of skin rugs will be located, this paper will record all known examples, discuss their general distribution, the methods of manufacture and the function of the designs on their surface. At the same time the writer will assemble and discuss relevant information gathered from the writings of early explorers and colonists about these articles of aboriginal clothing.

DISTRIBUTION

Those early writings show that the aborigines of Tasmania, Victoria, New South Wales, the southern half of South Australia and the south-western districts of Western Australia all wore skin rugs to keep themselves warm during the inclement weather. A number of illustrations made by these early writers have been chosen to show the rugs in use: plate 30 A, Peron and Freycinet (1807-16, plate 15), showing southern Tasmanians seated behind their wind-break; plate 30 B, Dumont D'Urville (1833, plate 24) depicting aboriginal groups from King George's Sound, southern Western Australia; plate 32 A, Mitchell (1838, plate 31), two men on the Bogan River of northern New South Wales wearing skin rugs; plate 32 B, Angas (1847, plate 18), an aboriginal from the Tatiara tribe of south-eastern South Australia; and plate 31 B, Ratzel (1896, p. 364), a painting by G. Murtz showing a family group, probably Victorian, resting in their camp. The writer has also located in the collection of the British Museum, a much-faded photograph of a Murtz sketch (plate 31 A), showing aborigines (probably in the same locality as the Ratzel illustration) capturing opossums, skinning them and drying their pelts, pegged to rectangular pieces of thick bark, in the front of their camp fire. Mountford and Harvey (1941, facing p. 162), illustrate how the women of the Adnjamatana tribe of the northern Flinders Ranges of South Australia carry their children in a skin rug, and Tindale and Lindsay (1963, plate 15) an aboriginal of the Jambina tribe of the Logan Creek, east-central Queensland, wearing a decorated skin rug.

Mountford (1960, fig. 1) depicted a decorated skin rug from Condah, Victoria. In this paper he describes and illustrates five additional rugs and two decorated skins; fig. 2, a rug from Echuca, northern Victoria; fig. 3, from the Hunter River, New South Wales; fig. 4, from the northern Flinders Ranges of South Australia; fig. 5, a skin cloak from Jarramungup, south-western Australia; plate 33 D, from Yorke Peninsula, South Australia; plate 33A, an unlocalized skin from New South Wales, and plate 33B, another from the northern Flinders Ranges of South Australia.

On fig. 1, I have noted the localities where, according to records both in literature and in museum registers, the aborigines used skin rugs for clothing.

(1) Geographe Bay, south-western Australia (Peron, 1809, p. 60).

(2) Jarramungup, south-western Australia (rug in Western Australian Museum).

(3) King George's Sound, southern Western Australia (D'Urville, 1833, plate 24).

(4) Parnkalla tribe, Eyre Peninsula (Angas, 1847, plate 59, no. 1).

(5) Marion Bay, Yorke Peninsula (rug in South Australian Museum).

(6) Flinders Ranges, South Australia, skin in National Museum of Victoria; rug in South Australian Museum.

(7) Lower Murray, South Australia (Angas, 1847, plate 42, no. 3).

(8) Tatiara Tribe, south-eastern South Australia (Angas, 1847, plate 4, no. 3).

(9) Echuca, northern Victoria (rug in National Museum of Victoria).

(10) Condah, south-western Victoria (Mountford, 1960, fig. 1).

(11) Gippsland, south-eastern Victoria (Howitt, 1904, p. 742).

(12) Yandah Station, northern New South Wales (Dunbar, 1943, p. 142).

(13) Narran, northern New South Wales (Parker, 1905, plate 31, p. 121).

(14) Bogan River, northern New South Wales (Mitchell, 1838, p. 742).

(15) Kamilaroi Tribe, northern New South Wales (Greenway, 1910, p. 196).

(16) Hunter River, eastern New South Wales, rug in Smithsonian Institution.

(17) Maria Island, Tasmania (Peron, 1809, p. 75).

(18) South-west Cape, Tasmania (Peron and Freycinet, 1807-16, plate 18).

(19) Logan Creek, east central Queensland (Tindale and Lindsay, 1963, plate 15).

This data suggests that the aborigines throughout Tasmania, Victoria, New South Wales, central Queensland, the southern part of South Australia and the south-western district of Western Australia, all utilized the pelts of animals for clothing. Although there are no records that the aborigines of the Great Australian Bight used skin rugs, it is reasonable to expect that they did so.

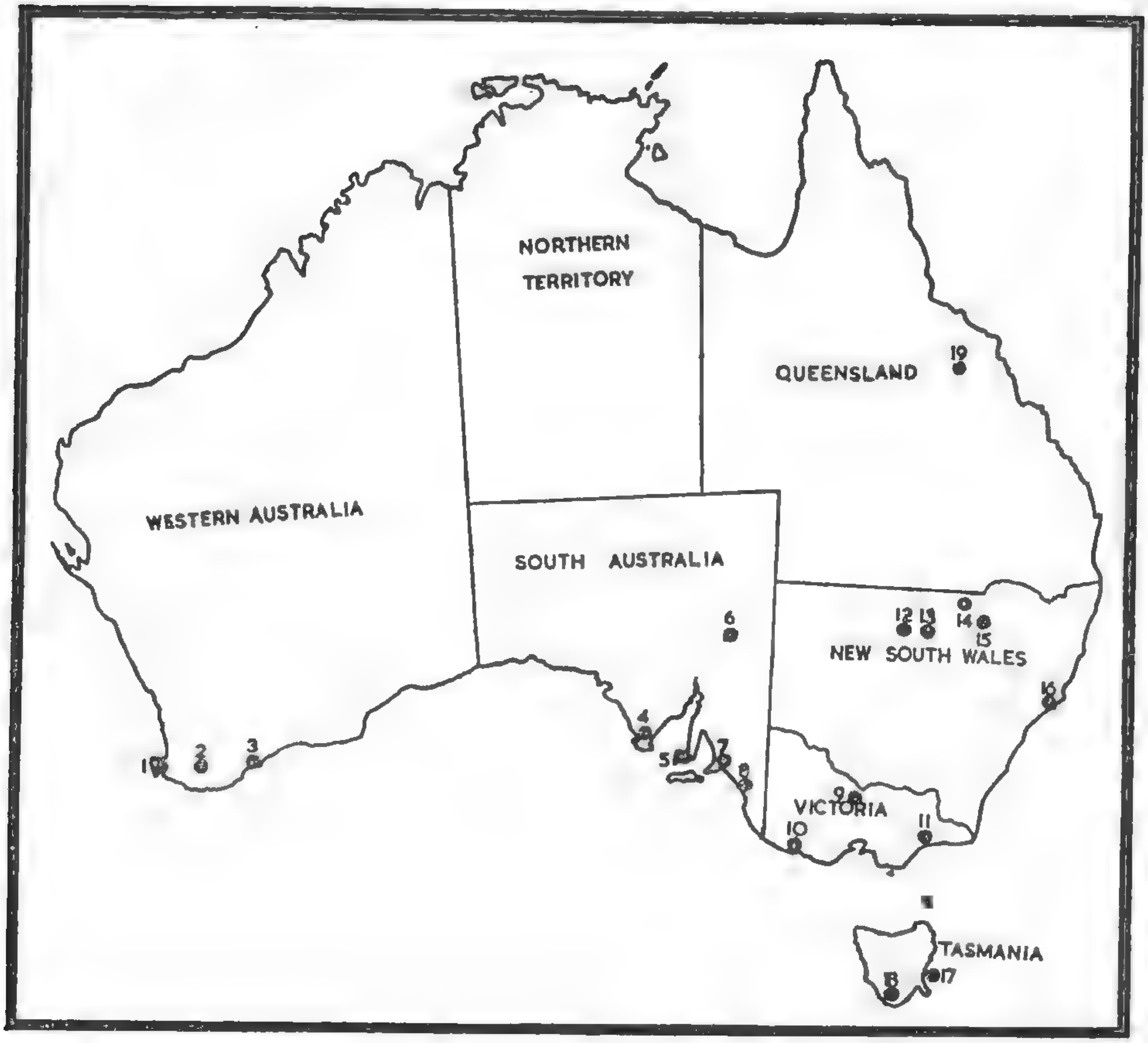


Fig. 1. Localities of aboriginal skin rugs mentioned in literature.

There is no evidence however, that the aborigines of northern Queensland, the Northern Territory or north-western Australia used skin rugs. This is understandable, for in those parts of the continent the average temperature would be much higher than in the southern half of the continent.

TYPES OF SKIN RUGS

The skin rugs used as clothing by the aborigines of Australia vary considerably in size and shape.

Tasmania

Peron (1809, p. 175), when describing a woman he saw at South-west Cape, Tasmania states "She was almost entirely naked, with the exception of the skin of a kangaroo, wherein she carried a little female infant." Later, on p. 217, when describing a number of men he saw on Maria Island, eastern Tasmania, Peron refers to a man ". . . older than the rest . . . had a skin of a kangaroo over his shoulders".

Plate 30 A, which is a copy of Peron and Freycinet's drawing (1807-16) Atlas No. 1,[1] shows a number of Tasmanian aborigines, most of them wearing small skin rugs; the woman with an infant is, almost certainly, the same as mentioned by Peron (1809, p. 175).

South-western Australia

Peron (1809), described two meetings with the aborigines near Cape Geographe, on the extreme south-west of Western Australia. On page 60, he wrote, "The native was an old man . . . he was entirely naked except that he had the skin of a kangaroo over his shoulders, which hung half way down his back". Later, on page 75, he noted, when describing a larger group of aborigines, that, ". . . the savages were entirely naked, excepting for a cloak made of the skin of a dog or kangaroo, which covered the shoulders of a few of them".

Peron's information was supported by a drawing of another early explorer, D'Urville (1833, plate 24), (plate 30 B is a copy), which shows the aborigines in King George's Sound, southern Western Australia, wearing what appears to be a cape (fig. 5) held by a cord around their necks.

(1) This drawing, with the addition of another aboriginal, carrying a barbed spear in one hand, a mainland type parrying shield in the other, and a stone axe in his belt and titled "Aborigines of New South Wales" was used as a frontispiece for the English translation of Peron's book, *Voyage of Discovery to the Southern Hemisphere* (1801-04). Luckily, Peron's detailed account (p. 75) of the aboriginal camp he saw at South-west Cape, Tasmania, removes all doubt that Peron and Freycinet's plate 18, in vol. 1 of their atlas, is the original and authentic drawing.

Hammond (1933, p. 30), states that the rugs worn by the aborigines of southern districts of Western Australia were made from one to three skins, according to the size of the wearer, hanging as low as the knees.

Hassel (1935, p. 276), when writing about the kangaroo of this area writes that it ". . . contributes his skin for making cloaks and rugs". Calvert (1894, p. 25), in his book on "The Aborigines of Western Australia" states that "in the colder parts of the continent he (the aboriginal), sometimes wears a small kangaroo-skin cloak".

Bates (1938, p. 60), states that the cloak of the aborigines in southern Western Australia consisted of the skins of seven kangaroos. The rug in the collection of the Western Australian Museum (fig. 5), is also made of seven skins, sewn together in the form of a cape.

South Australia

Angas (1847, plate 8, no. 1), illustrates a mother and child from the Adelaide tribe; another, his plate 18, no. 4 (plate 32 B is a copy), shows an aboriginal from the Tatiara tribe of south-eastern South Australia, and a third, his plate 8, no. 3, from the Parnkalla tribe of Eyre Peninsula, all of whom are shown wearing skin cloaks that reach below their knees. The skin rug from Marion Bay, Yorke Peninsula, (plate 33 D), in the collection of the South Australian Museum, is about four feet square, while the example from the Flinders Ranges (fig. 4), made up of 36 skins, is approximately five feet long and three feet wide.

Victoria

In Victoria, the skin rugs were much larger than those already described. The Condah rug, described by Mountford (1960, fig. 1), made up of 50 opossum skins, is approximately six feet long and five feet wide, and the Echuca rug, described in this paper (fig. 2), consisting of 81 skins, is seven feet, six inches long and five feet, six inches wide.

In the Murtz sketch (plate 31 A), the rug worn by the aboriginal on the left reaches well below his knees. On the other hand, the man in the Ratzel illustration (plate 31 B), has only a single skin fastened around his waist. The two women on the right, however, are wearing voluminous decorated rugs.

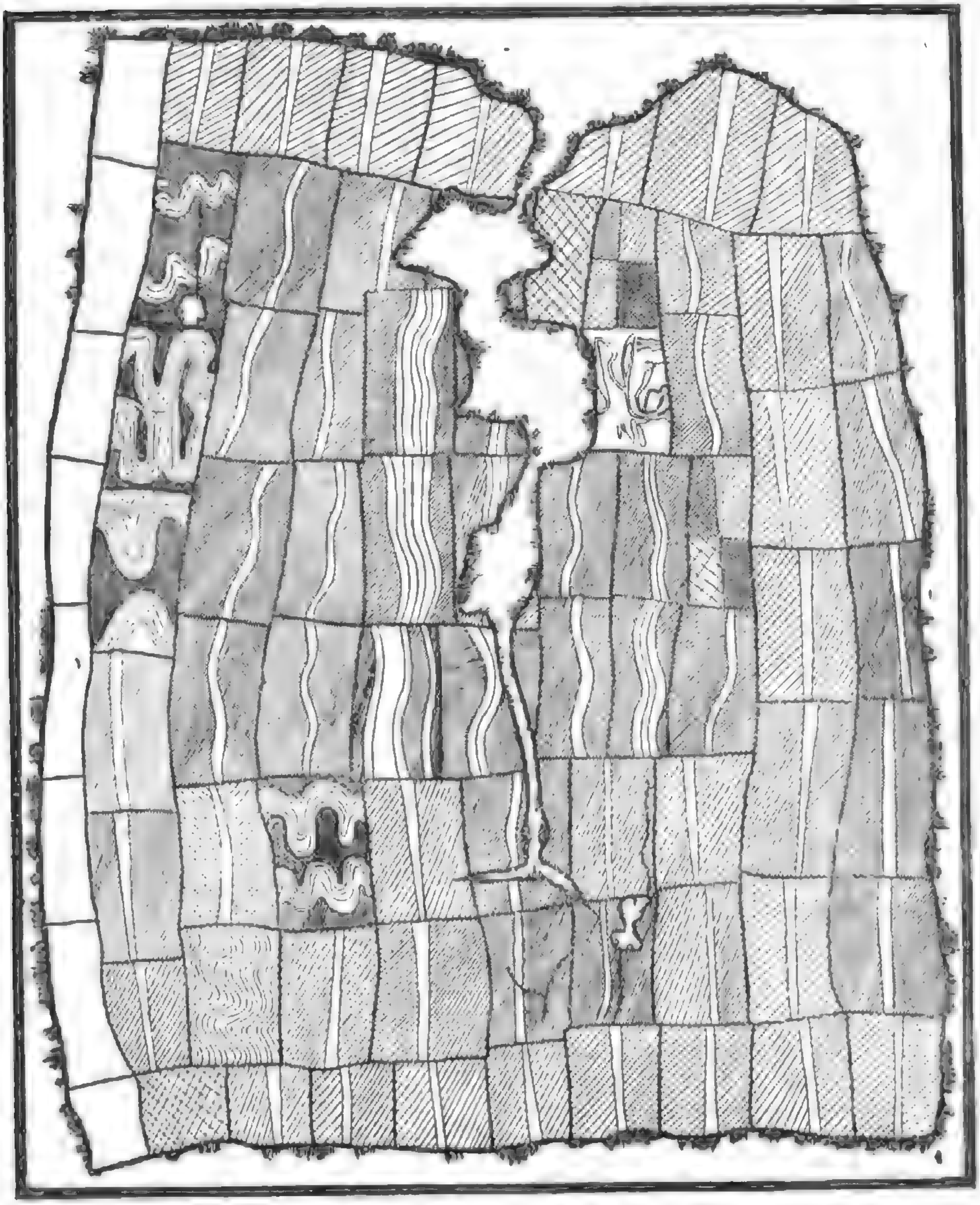


Fig. 2. Aboriginal skin rug from Echuca, northern Victoria

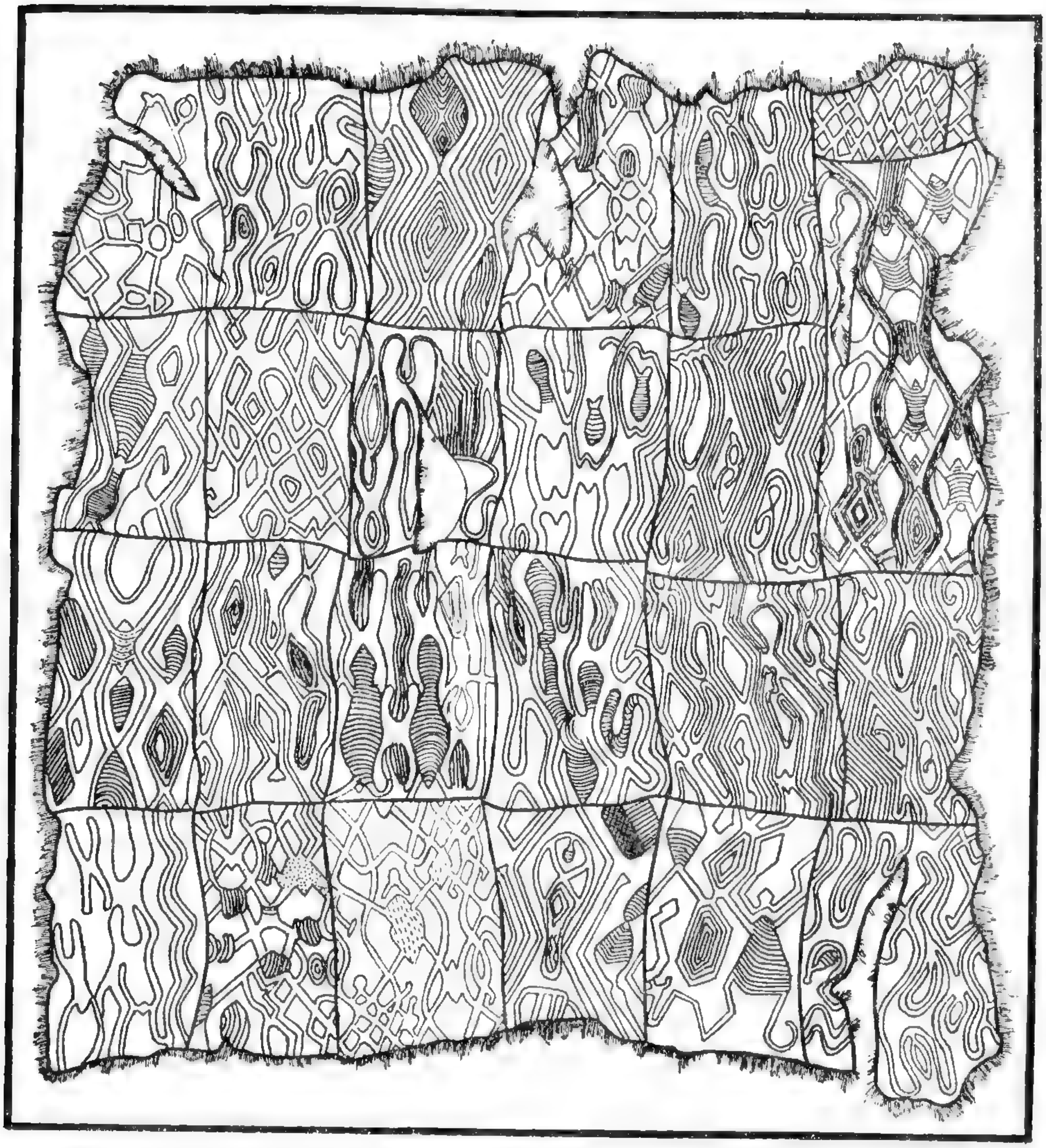
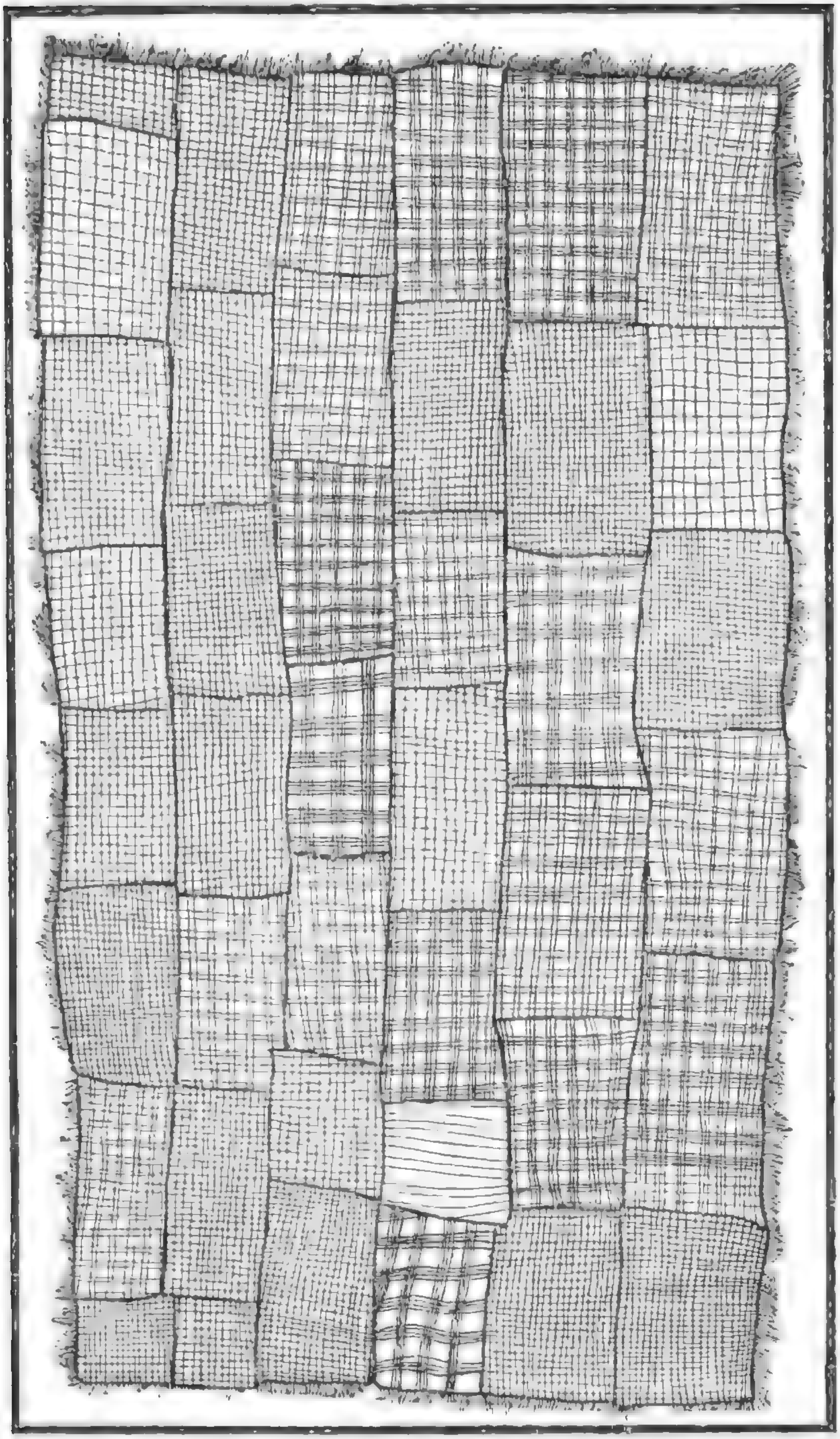


Fig. 3. Aboriginal skin rug from Hunter River, eastern New South Wales.

Fig. 4. Aboriginal skin rug from Adnyamatana Tribe, northern Flinders Ranges, South Australia.



New South Wales

The rug (fig. 3), from the Hunter River, New South Wales, made up of 22 skins, is approximately five by four feet in area. Mitchell (plate 32 A), depicts two aborigines on the Bogan River area of New South Wales, one whose rug reaches to his knees, and the other wearing what appears to be a single skin barely covering his body.

This survey shows that, although the rugs worn by the aborigines of Victoria, New South Wales, Queensland and South Australia were usually large enough to cover the whole body down to the knees, those used by the Tasmanians and the natives of southern Western Australia appear to have been considerably smaller in area. According to Tindale and Lindsay (1963, plate 15) the skin rugs worn by the aborigines of the Logan River of Queensland were almost as voluminous as those worn by the Victorians.

TECHNIQUES OF MANUFACTURE

Scattered throughout the early Australian writings are many details and several excellent descriptions of the techniques used by the aborigines in the manufacture of their skin rugs.

The earliest of these records was by Daniel Bunce (1857, p. 75), who, when describing his experience in Victoria wrote:—"Many opossums had been caught during our excursion, and the skins were now pegged out on sheets of bark and stretched to their fullest extent with wooden pegs . . . The points of these pegs, previously hardened in the fire, had been scraped with a piece of broken glass bottle . . . After the skins had been sufficiently stretched and dried, they were curiously marked, the work of the men, animals, kangaroos, emus, as well as human figures frequently represented by a piece of glass, or when not, by the bowl of a metal spoon, filed sharp for the purpose of scratching the skin when in the soft state. Prior to the introduction of needles and thread, they (the aborigines) used the finer tendons of the kangaroo and opossum for thread, and the sharpened bone of a fish or kangaroo as a needle for sewing their skin rugs".

Bunce's evidence is supported by several independent sources. Krefft (1862, p. 362), when writing of the customs of the aborigines of the Murray and Darling Rivers states, "Nearly all the trees along the river showed more or less, . . . where square pieces of bark for drying their opossum skins on had been cut, often to the height of 30 feet above the ground".

An examination of the two Murtz sketches (plate 31), shows some of the techniques mentioned by Bunce and Krefft. In the background of plate 31 A, some men are capturing opossums. On the extreme left, one man has lit a fire at the base of a hollow tree, while another is waiting at the top to club the opossum as it endeavours to escape from the smoke. In the centre of the illustration another aboriginal is ascending the tree by means of a climbing vine in pursuit of an opossum, whilst his companion, stick in hand, is waiting to kill the creature when it jumps to the ground.

In the left foreground, a man, returning to camp, is carrying a number of opossums, other aborigines are skinning the creatures, whose pelts, held on rectangles of thick bark of the gum tree with wooden pegs, are drying around a camp-fire. These rectangles of bark, similar to those previously mentioned by Krefft, have been removed from the tree on the extreme right.

On plate 31 B, a Murtz sketch in Ratzel (1896, p. 364), a number of opossum skins, now decorated with simple designs, but still pegged out on the squares of bark, are drying beside the fire.

Although Bunce states that the skins were decorated with a piece of glass or a sharpened spoon (obviously the effects of civilization), Smyth (1878, p. 349), states that "The mussel shell, *u-born*, is used by the natives for scraping and preparing the skin for bags, rugs, etc.". Howitt (1904, p. 742), who claims that the aborigines did not dress their skins, but merely dried them, states that "to make them more pliable, they cut markings in the skin sides with mussel shell (*nandueung*)."

Dunbar (1943, p. 142), when describing the skin rugs of the Ngemba tribe of the Darling River writes: "Skin rugs were made of the skin of the doe kangaroo, *murraway*; this was stretched and dried in the shade, rubbed with ashes, then with emu oil or goanna fat, and pulled backwards and forwards over a smooth-barked tree to make it pliable. Other than this, no attempt was made at tanning. The skins were roughly trimmed and sewn together by threads of kangaroo-tail sinews, and, in the cold weather, the cloak was worn with the fur side inwards". Dunbar makes no reference to decorations on the inside of the rugs.

Worsnop (1897, p. 15), described the manufacture of the skin rugs of the South Australian aborigines thus, "Their opossum rugs, or cloaks of kangaroo skins, after having been stretched and dried before a fire, or in the sun, are roughly trimmed and sewn together by kangaroo sinews, the edges of the skin are pierced with a sharp-pointed bone for the sinews to pass through. When a sufficient number of skins are sewn together, the next operation is to ornament the inner, or flesh side of the cloak, which is done by doubling over a part of the skin, a few inches at a time, and scraping the narrow edge with a flint, or the sharp edge of a shell. The design usually partook of a zig-zag, or diamond pattern (see plate 32 B and plate 33 D), according to the taste of the wearer''[2].

During the writer's investigations of the Adnjamatana tribe of the northern Flinders Ranges of South Australia, the aborigines showed him how they folded and scored their skins in a similar manner to that described by Worsnop (1897). Plate 33 C also illustrates a northern Flinders aboriginal demonstrating, on a completed rug, the method of using a large stone implement, *utuna,* to dress a skin.

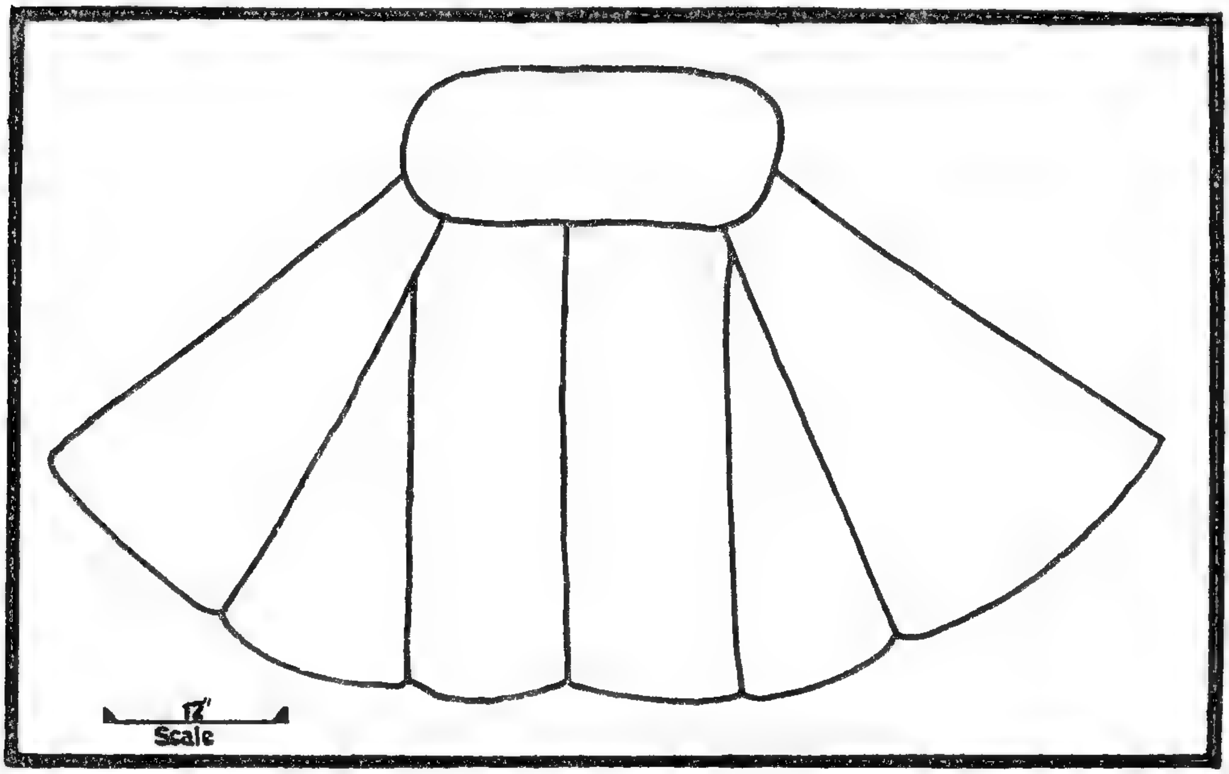


Fig. 5. Rough sketch of kangaroo-skin cape from Jarramungup, south-western Western Australia.

(2) The writer feels sure that Worsnop is wrong in one particular. The skins are decorated before being sewn together. This is evident on an examination of the skin rug from Marion Bay (plate 33 D), the skins from the northern Flinders Ranges (plate 33 B), the Murtz illustration in Ratzel (plate 31 B), and the Condah rug (Mountford, 1960, fig. 1).

Edwards (1963), has described a large series of kidney-shaped stones, most of them from southern South Australia, which the aborigines had used when preparing skins for their rugs.

Hammond (1933, p. 30), in describing the methods adopted by the aborigines of Western Australia when making their *bouka* or kangaroo skin capes (fig. 5) wrote: "After the kangaroo had been skinned, the skin is pegged out in the usual way and left until half dry. It is then smeared all over with grease. Using a small sharp-edged stone, the natives would then scrape it until it was quite flexible, occasionally working it with grease. When finished, it was as pliable as any tanned skin. In making the *bouka*, the chosen skins would be laid, side by side, on the ground, and the adjoining edges would be trimmed with a sharp stone so that they met evenly. The trimmed edges were sewn together with kangaroo sinews . . . The sewing would be done by pricking holes in the skin with a wooden needle . . . then pushing the sinews through with the fingers. The stitches were from a quarter to three-eighths of an inch apart, and looked like a sort of blanket stitch. The children wore one-skin *boukas* except in hot weather"[(3)].

Summarizing the available evidence on the manufacture of aboriginal skin rugs, it would appear that the animal was skinned, its pelt stretched on a sheet of bark, or on the hard ground, until dry, or partly so. The skin was then dressed and on most, but not on all occasions, decorated before it was trimmed and sewn together in the form of a cape or a rug.

METHODS OF WEARING RUGS

In general, the aborigines on the mainland of Australia (plate 31 A, B), and in Tasmania (plate 30 A), wore their skin rugs by passing one edge under the right arm and fastening it to the other edge with a bone skewer on the left shoulder. This method of wearing the cloak allowed perfect movement for both arms.

D'Urville's sketch (plate 30 B), of the aborigines of King Georges Sound, Western Australia shows that skins were worn across the shoulders in the same manner as a cape.

(3) The child in the foreground of D'Urville's illustration (plate 30 B) is wearing a single skin.

Gouger (1838, p. 50), when writing of the Adelaide tribe says, "The women carry their children behind their backs in the part of the kangaroo rug enveloping them, so tied that the upper part forms a sort of a hood". Mountford and Harvey (1941, facing p. 162) illustrated an aboriginal woman from the Adnjamantana tribe of the northern Flinders Ranges, carrying her child in a similar manner. The Tasmanian mother on plate 30 A, with her rug around the shoulders, is holding a child in her arms; others are wearing their rugs across their left shoulders.

DECORATIONS AND THEIR MEANINGS

There is no evidence that the aborigines of Tasmania or south-western Australia used any designs on the inside of their skin rugs. Those, however, who inhabited the southern districts of South Australia decorated their rugs with diamond-shaped patterns (plates 32 B and 33 D), and in the northern Flinders with square designs (fig. 4, and plate 33 B, C).

The few available illustrations, specimens in museum collections and references in literature all show that the aborigines in both Victoria and New South Wales decorated the inner surfaces of their skin rugs with elaborate designs. Dawson (1881, facing page 8); Ratzel (1896, p. 364), (plate 31 B); Murtz (plate 31 A, and Mitchell (1838) (plate 32 A), all illustrated aboriginal men and women wearing these decorated skin rugs. Ratzel (1896, p. 364) figures an unlocalized skin rug; Mountford (1960, fig. 1) a rug from Condah, southern Victoria and in this paper describes and illustrates a skin (plate 33 A), from an unlocalized locality in New South Wales; a rug from Echuca, northern Victoria (fig. 2), and another from the Hunter River, New South Wales (fig. 3).

Many writers have made passing references to these decorated rugs. Strutt (1858, p. 62), states, "The fur rugs were made from opossum skins and decorated with various devices (designs), on the inside in red and black;" Parker (1905, p. 121) records that ". . . Their opossum skin rugs used to have designs scratched on their skin sides and also painted patterns . . ."; Hull (1858, p. 62) also stated that "The opossum-skin rug and cloak was much ornamented with rude engravings of rivers, camps, animals, etc., etc., scratched on the skin with a mussel shell".

Smyth (1878, p. 228), when referring to the Victorian rugs, notes that, "The inner sides of the opossum rugs . . . were usually ornamented. They (the aborigines) inscribed lines on the skin and darkened them with powdered charcoal, fat and with other colours. The figures were the same as those on their weapons, namely, the herring-bone, chevron, and saltier, with representations of animals in outline . . . When an animal was figured, it is common, as in the drawings I have given (fig. 48), to fill in the space around it with lines". Later Smyth (1878, p. 294), quoting Bulmer said, "In ornamenting their rugs, they copied from Nature. One man . . . got his ideas from natural objects . . . the markings of a grub, called Krag, and from the snakes and from the markings of lizards he derived new designs. The natives, in adorning their rugs, and weapons . . . imitated the forms of the plants and trees".

Bunce (1858, p. 103), writes, "After the skins had been sufficiently stretched and dried, they were curiously marked, the work of the men, animals, kangaroos, emus as well as human figures frequently represented".

There are many different opinions among the early writers regarding the meanings of the designs which the aborigines inscribed on their rugs. The following is a selection of the opinions expressed: Parker (1905, p. 21) records ". . . have designs scratched on their skin rugs, also painted patterns. Some say tribal marks, others, just to look pretty and to distinguish one from another's"; Frazer (1893, p. 201), when speaking of body scarring writes, "I think it is likely . . . that each family had its own *mombarai* which belonged to each clan of the tribe, for a friend of mine tells me that . . . he had an opossum rug made for him by a man of the Kamilaroi tribe, who marked it with his *mombarai*. When the rug was shewn to another black some time later, he at once exclaimed, 'I know who made this, here is his *mombarai*'." Greenway (1910, p. 198), when referring to the burial customs of the same tribe states, "On the bare part of the tree, certain marks were cut to correspond with the marks on the dead man's 'possum rug or cloak, for each man's rug is particularly marked to signify its particular ownership"; Howitt (1904, p. 741), says that, "The markings are called *waribruk* and each man had his own. Fig. 50 shows examples of the *waribruk* known to me".

This selection of writings from the early observers suggest that some, but not all, of the symbols engraved on the skin rugs of eastern and south-eastern Australia were the personal marks of the owners. There must have been occasions, however, when the artist, to satisfy his aesthetic sense, would have decorated his rug with designs that had no totemic meaning. The simple designs on the South Australian rugs were, without doubt, used only for decoration and to make the skins more flexible.

DESCRIPTION OF RUGS

Fig. 2 illustrates an opossum skin rug collected at Echuca, on the River Murray in 1853. Approximately 83 inches long and 69 inches wide, it is made up of 76 decorated and seven undecorated skins, laid in 11 rows. The individual skins have been skilfully sewn together with fine sinews and the designs cut into the surface with some sharp tool, possibly, as recorded by Smyth (1878, p. 349), with the sharp edge of a mussel shell. A few of the skins in the lower left-hand corner have been coloured with red ochre. Although this rug, which is in the National Museum of Victoria, has been torn almost in halves, it has been possible by means of photography, to obtain an almost complete record of the designs engraved on its inner surface.

There is little doubt that some, if not all of the designs were personal symbols or totemic marks of the owner, a number of them being similar to those which Howitt (1904, fig. 50), stated belonged to aborigines with whom he was acquainted.

Fig. 3, from the Hunter River, eastern New South Wales, collected by Commander Wilkes on the United States exploring expedition of 1838-42, is now housed in the Smithsonian Institution in Washington, D.C.

The rug, which is 58½ inches long and fifty inches wide contains 22 regularly cut skins of the brush-tailed opossum, *Trichosurus vulpecula*, a smaller piece of the same material and a skin of the great grey kangaroo (*Macropus cangaru*)[4].

The skins were laid in two rows of five skins, and two rows of four, the kangaroo skin and the small piece of opossum skin filling in the upper right-hand corner to complete the rectangle. The skins are sewn edge to edge, with very fine stitching of cotton cord. The number of designs on this rug that resemble each other suggest that they too, like those on the Echuca rug (fig. 2), may have represented the personal marks of the owner[5]

(4) These skins were identified by Dr. David Johnson, Curator of Mammals, Museum of Natural History, Smithsonian Institution, Washington D.C.

(5) This rug has been figured by Schuster (1961, essay 27, fig. 7).

Fig. 4 illustrates a skin rug collected by the writer from the aborigines of the northern Flinders Ranges of South Australia. It is made up of 41 rabbit skins, laid in six rows and sewn together with sinews, probably those from the tail of a kangaroo. Each skin had been decorated with a varied and interesting series of square designs.

The aborigines explained that opossum skins would have made a warmer and much more durable rug, but, as, in more recent years, these creatures had become scarce, they had been forced to use the skins of rabbits.

Plate 33 D, from the collection of the South Australian Museum, is a section of a skin rug made from opossum skins in recent years by an old aboriginal woman of Yorke Peninsula in South Australia. This rug, about four feet square, is decorated with diamond-shaped patterns typical of southern South Australia (see plate 32 B).

Plate 33 A, is a single decorated skin from New South Wales. Its specific locality is not recorded in the register of the British Museum, where the specimen is housed. The diamond-shaped patterns on this skin, partly coloured with some pigment, possibly red ochre, are unlike those used in South Australia.

Plate 33 B is a single skin, collected in the northern Flinders Ranges of South Australia, and now in the collection of the National Museum of Victoria. The designs consist of squares similar to those on the Flinders Range rug (fig. 4).

SUMMARY

This paper illustrates and describes all the known examples of aboriginal skin rugs and decorated skins in existence, surveys and early literature which describes the types of skin rugs used by the aborigines of Australia, gives the techniques employed in their manufacture, the methods of wearing, the decorations inscribed on their surfaces, and their possible meanings.

ACKNOWLEDGMENTS

For assistance in this research I wish to acknowledge help received from the Board of Governors of the South Australian Museum and for the use of their facilities; to the National Museum of Victoria for permission to photograph and describe the aboriginal rugs in their collection; to Mr. A. Massola, the Curator of Anthropology of that Institution for his ever-ready help; to Mr. I. Crawford, the Curator of Anthropology of the Western Australian Museum, for his sketch of the Jarramungup rug, and to Mr. B. Cranstone, Curator of Oceanic Ethnography of the British Museum, for his kindly assistance.

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DESCRIPTION OF PLATES 30-33

PLATE 30

A. Tasmanian aborigines at South-West Cape, Tasmania, wearing skin rugs (Peron & Freycinet).

B. Aborigines of King George Sound, south-west of Western Australia, wearing skin capes (Dumont D'Urville).

PLATE 31

A. Aborigines (probably Victorian), catching opossums and drying skins (Murtz).

B. Family group (probably Victorian) in camp, with decorated opossum skins, on squares of bark, drying beside the camp fire (Murtz, in Ratzel).

PLATE 32

A. Aborigines of the Bogan River, New South Wales, wearing skin cloaks (Mitchell).

B. Aboriginal from the Tatiara tribe, South Australia, wearing skin rug (Angas).

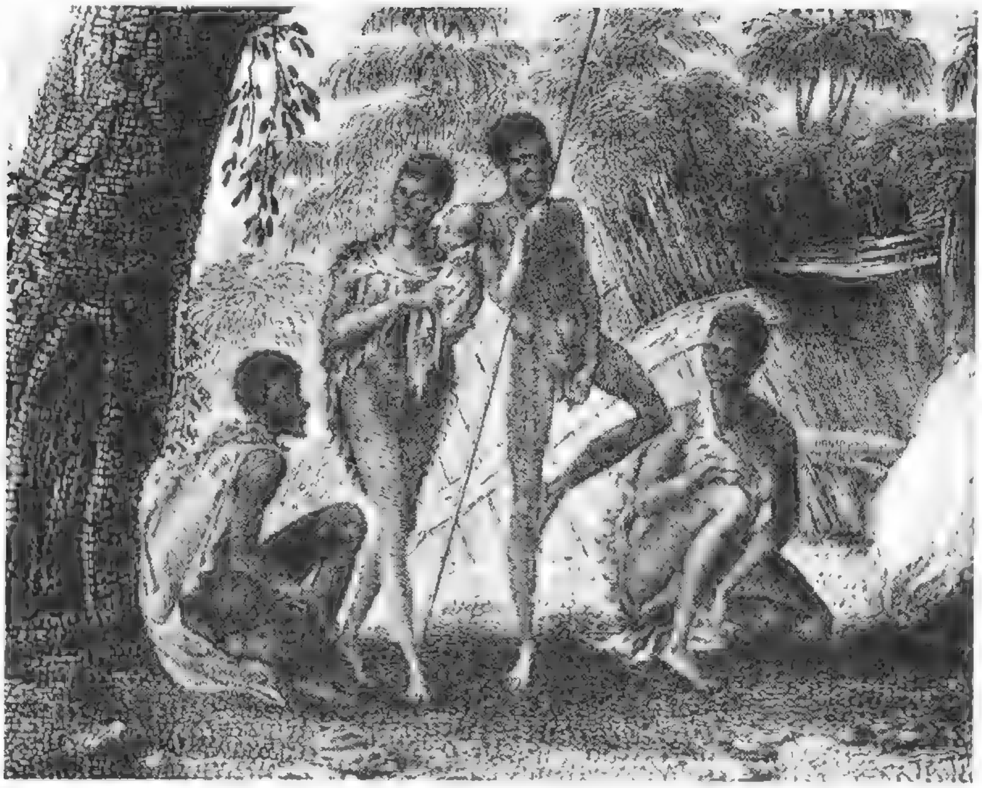
PLATE 33

A. Decorated skin, New South Wales.

B. Decorated skin, Northern Flinders Ranges, South Australia.

C. Method of fleshing skin with stone implement, northern Flinders Ranges.

D. Section of decorated skin rug, Yorke Peninsula, South Australia.



A

B

Tasmanians and Western Australians wearing skins.

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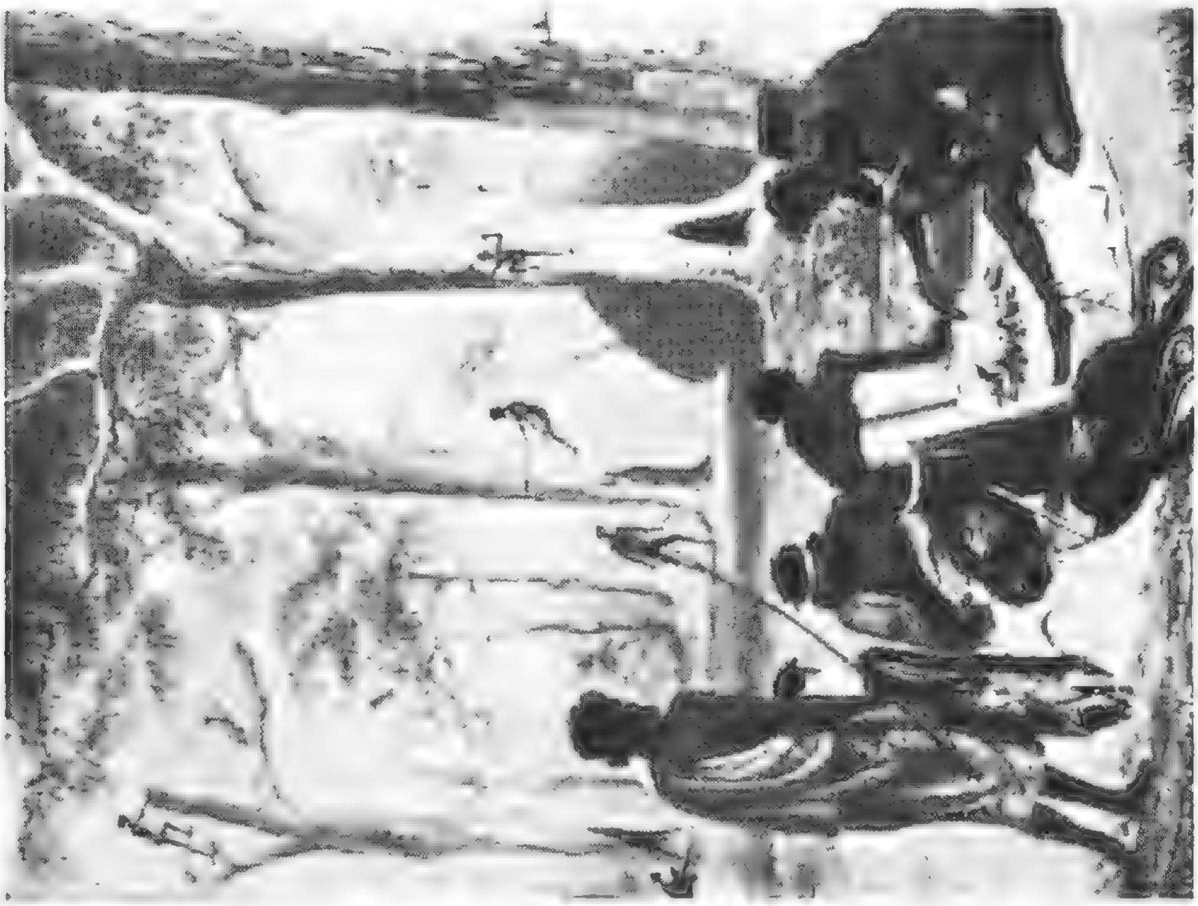
A



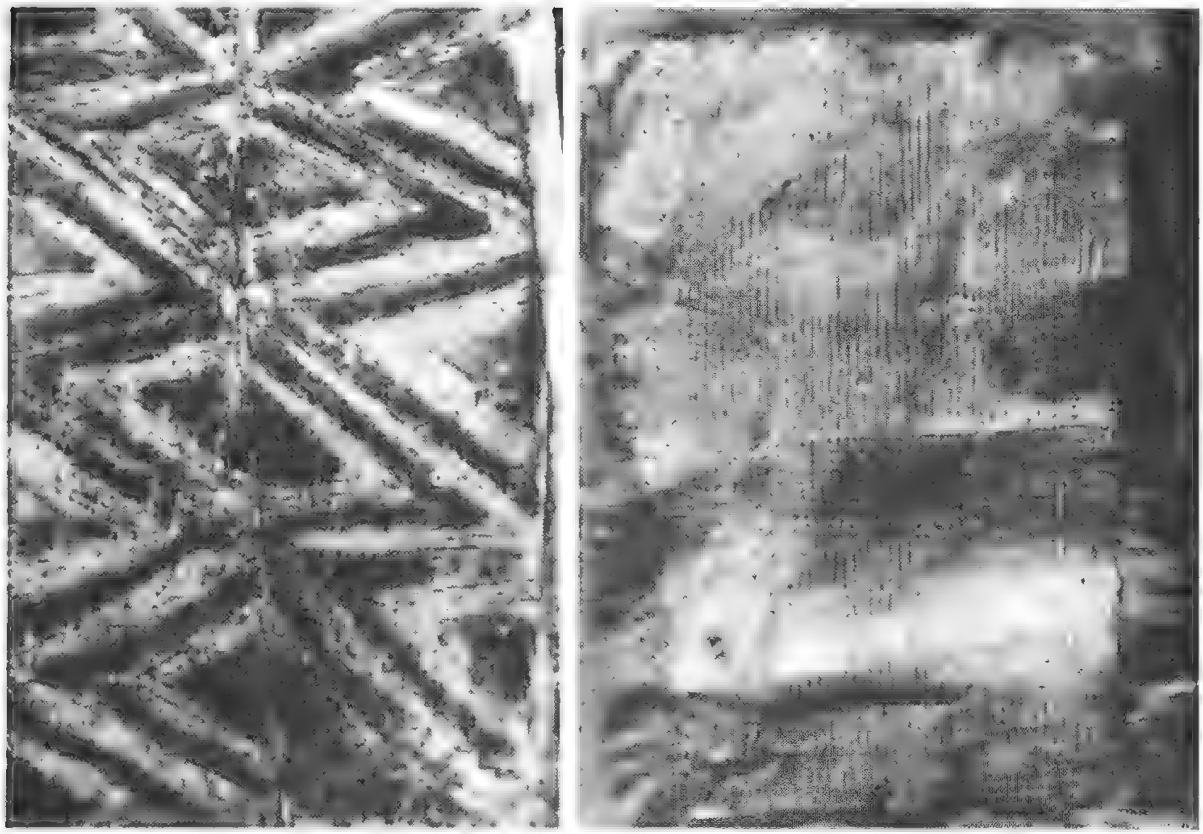
B

Preparation of opossum skins.

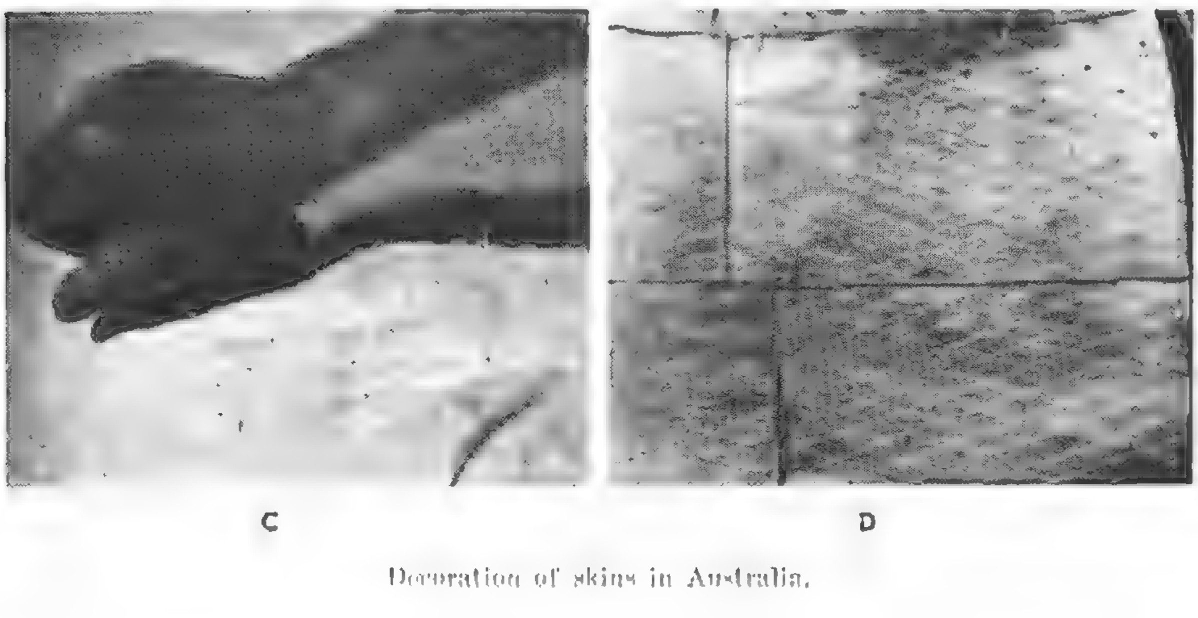
A

B

Australians wearing skins.



A B



C D

Decoration of skins in Australia.

THREE NEW SPECIES OF THE GEKKONID LIZARD GENUS DIPLODACTYLUS GRAY FROM AUSTRALIA

By Arnold G. Kluge[1], *Department of Biology, University of Southern California, Los Angeles, California*

Summary

In preparation for a revision of the large and complex gekkonid lizard genus Diplodactylus Gray a study was made of all the specimens deposited in Australian university and museum collections. During this study a few specimens were discovered which apparently represent three undescribed species. It is not surprising that these populations appear to be restricted to two regions already supporting a large number of plant and animal relicts. Two of the species are known only from the Carnarvon and North-West Natural Regions of Western Australia and the third from central Australia. All the new forms belong to the vittatus species group which at present includes byrnei Lucas and Frost, conspicillatus Lucas and Frost, pulcher (Steindachner), steindachneri Boulenger, tessellatus (Gunther), and vittatus Gray. This species group is characterized by relatively long and slightly expanded digits with moderately large subapical plates, preanal pores either present or absent and a cloacal spur consisting of a cluster of ridged spine-like scales.

THREE NEW SPECIES OF THE GEKKONID LIZARD GENUS DIPLODACTYLUS GRAY FROM AUSTRALIA

By ARNOLD G. KLUGE[1], Department of Biology, University of Southern California, Los Angeles, California

Plates 34-35

In preparation for a revision of the large and complex gekkonid lizard genus *Diplodactylus* Gray a study was made of all the specimens deposited in Australian university and museum collections. During this study a few specimens were discovered which apparently represent three undescribed species. It is not surprising that these populations appear to be restricted to two regions already supporting a large number of plant and animal relicts. Two of the species are known only from the Carnarvon and North-West Natural Regions of Western Australia and the third from central Australia. All the new forms belong to the *vittatus* species group which at present includes *byrnei* Lucas and Frost, *conspicillatus* Lucas and Frost, *pulcher* (Steindachner), *steindachneri* Boulenger, *tessellatus* (Gunther), and *vittatus* Gray. This species group is characterized by relatively long and slightly expanded digits with moderately large subapical plates, preanal pores either present or absent and a cloacal spur consisting of a cluster of ridged spine-like scales.

I wish to extend my gratitude to the curators of the following institutions for their assistance during my study tour and for the opportunity to describe specimens under their care: Harold G. Cogger, Australian Museum (A.M.), F. J. Mitchell, South Australian Museum (S.A.M.) and Glen M. Storr, Western Australian Museum (W.A.M.). I also wish to thank A. R. Main of the Department of Zoology, University of Western Australia (U.W.A.) for reading the manuscript.

Diplodactylus galeatus sp. nov.

Holotype: S.A.M. R973. Collected in the Stuart Range, South Australia by Henry Greenfield on 15 October, 1920.

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[1] Postgraduate Fulbright Scholar, during 1961-62, at the University of Western Australia.

Diagnosis: *Diplodactylus galeatus* can be distinguished from all other members of the *vittatus* species group by the following combination of characters: (*a*) dosal body scales moderately large and swollen; (*b*) tail relatively long, round in cross section, covered dorsally with regular annuli of slightly enlarged tubercles; and (*c*) a colour pattern consisting of a continuous post-orbital streak over occipital region and a series of large conspicuous circular marks on dorsum of body (plate 34, A).

Description of holotype: Head moderately deep; eye large; snout relatively long; rostral rectangular, slightly more than twice as wide as high; dorsomedian rostral crease absent; nostril small, directed posterolaterally, surrounded by rostral, first supralabial (broadly in contact), two supranasals and four postnasals; anterior-most supranasal large, meeting counterpart on midline (internasal absent); scales immediately posterior to supranasals slightly enlarged and swollen; scales of snout moderately large, 9/11 between postnasals and preocular granules (left and right sides respectively); 8/9 supralabials, slightly decreasing in height posteriorly; 24 scales between centrolateral margins of orbits (excluding those of dorsal eyelids); 2/4 extremely small spinose scales on posterior border of dorsal eyelid; mental almost quadrangular, longer than wide; 10/11 infralabials; scales bordering mental and infralabials slightly enlarged and flattened, gradually grading into small conical granules of throat region; external ear opening relatively small, almost round, slightly below level of angle of jaw; occipital and temporal regions of head covered with moderately large conical scales; dorsal surface of body covered with large swollen scales separated by minute triangular granules (pl. 34, A); enlarged dorsal body scales rapidly grade into conical granules of sides and venter; granules of venter slightly imbricate, one-half times as large as swollen dorsals; limbs covered with relatively small imbricate conical scales; digits relatively long, narrow and depressed; subdigital surfaces covered with single row of enlarged swollen scales; 7/7 swollen scales covering inferior surface of fourth finger, 9/8 covering fourth toe; subapical plates large, much wider than more proximal width of digit; nails extremely short, strongly curved, not projecting distally beyond claw sheath; tail moderately long, slightly swollen at base; tail covered above with large spinose tubercles in regular annuli which are in contact or separated by one or two rows of smaller conical scales; subcaudals approximately one-half times as large as dorsal tubercles; male; cloacal spur consists of cluster of 8/6 sharply pointed strongly projecting spines; preanal pores absent.

Dorsal ground colour uniform yellowish-brown (probably slightly faded due to preservation); dark brown postocular streak continuous behind occipit, encloses uniform yellow region (plate 34, A); small yellow spot on side of neck; four large light diamond-shaped marks on dorsum of body (one pectoral, two midbody and one pelvic); dorsal surface of tail with faint indication of four irregular enclosed or open large circular marks; all dorsal body and tail colour patterns bordered by very dark brown; all ventral surfaces immaculate white, chromatophores absent.

Snout-vent length 52.7 (all measurements given in millimeters); length of tail 27.0; length of head 14.8; length of snout 5.3; diameter of orbit 4.1; distance between eye and ear 4.8; width of head 10.2; distance between axilla and groin 23.4; length of fore limb 20.3; length of fourth finger 3.8; length of hind limb 25.0; length of fourth toe 4.2.

Variation: In addition to the holotype, *Diplodactylus galeatus* is known from the following specimens: (*a*) S.A.M., R1563, Hermannsburg, Northern Territory and (*b*) A.M. R11995, 4 miles north of Alice Springs, Northern Territory. These specimens agree with the holotype in all important characters and exhibit the following variation: dorsomedian rostral crease one-fourth total height of rostral; two to five, avg. 3.2, postnasals; eleven to twelve, avg. 11.5, scales between postnasals and preocular granules; nine supralabials; twenty-four to twenty-eight, avg. 26.0, scales between centrolateral margins of orbits; three to four, avg. 3.5, extremely small spinose scales on posterior border of dorsal eyelid; mental lanceolate, slightly to much longer than wide; ten to twelve, avg. 11.0, infralabials; scales bordering mental and infralabials small to slightly enlarged; external ear opening very small; dorsal surface of body covered with moderate to very large swollen scales; minute triangular dorsal granules absent or extremely small; sides of body and venter covered with small slightly flattened imbricate scales; seven to eight, avg. 7.8, swollen scales covering inferior surface of fourth finger, eight to eleven, avg. 9.3, covering fourth toe; nails extremely short to long, not or but slightly extending beyond claw sheath; tail relatively short in S.A.M. R1563 (absent in A.M. R11995); annuli of large spinose tubercles of tail in contact or separated by one to four rows of smaller conical scales; subcaudals slightly smaller than dorsal tubercles of tail; both males; cloacal spur consists of cluster of five to six, avg. 5.3, spines; dorsal ground colour uniform yellow or dark reddish-brown; no indication of spot on side of neck; four to five large light almond-shaped or irregular circular marks on dorsum of body (one pectoral, two to three midbody and one pelvic); dorsal surface of tail devoid of colour pattern.

Relationships: Within the *vittatus* species group, *galeatus* appears to be most closely related to *tessellatus*. This relationship is inferred from their similar head and body proportions and the type of midbody and tail scalation. *Diplodactylus galeatus* can easily be distinguished from *tessellatus* by its peculiar colour pattern (in *tessellatus* the dorsal surfaces of the head and body are uniform or marbled grayish-brown). *Diplodactylus tessellatus* is known from the Everard Ranges, South Australia and Newcastle Waters, Northern Territory.

Etymology: The specific name is derived from the past-participle of the Latin word *galea*, meaning covered with a helmet, thus drawing attention to the occipital cap formed by the continuous dark brown postocular streak (plate 34, A).

Diplodactylus mitchelli sp. nov.

Holotype: W.A.M. R14823. Collected at Coolawanyah homestead, Pilbara Division, Western Australia, by F. J. Mitchell on 17 July, 1958.

Diagnosis: *Diplodactylus mitchelli* can be distinguished from all other members of the *vittatus* species group by its larger size, relatively large and flattened dorsal body scales and colour pattern (plate 34, B).

Description of holotype: Head slightly depressed; eye large; snout long; rostral rectangular, almost two and one-half times wider than high; dorsomedian rostral crease slightly more than one-fourth total height of rostral; nostril moderately large, directed dorsolaterally, surrounded by rostral, first supralabial (broadly in contact), two large supranasals and three postnasals; anterior-most supranasal extremely large, broadly in contact with counterpart on midline (internasal absent); single very large flat scale immediately posterior to supranasals; scales of snout moderately large and swollen, 10/11 between postnasals and preocular granules (left and right sides respectively); 8/7 large supralabials, of equal height to below pupil; 24 scales between centrolateral margins of orbits (excluding those of dorsal eyelid); frontal region strongly concave; 4/3 very small spinose scales on posterior border of dorsal eyelid; mental lanceolate, slightly more than twice as long as wide; 10/10 infralabials, rapidly decreasing in size posteriorly; two rows of large flattened postmentals, rather sharply defined from small conical granules of throat region; external ear opening very small, oval, at level of angle of jaw; occipital and temporal regions of head covered with moderately large oval scales; mid-dorsal surface of body covered with very large slightly imbricate plate-like scales, two to two and one-half times larger than small imbricate cycloid ventrals; enlarged plate-like scales of dorsal body surface gradually grade into smaller and more imbricate scales of sides of body (plate 34, B); limbs covered with moderately large slightly imbricate conical scales; digits very long, narrow and depressed; subdigital surfaces covered with single row of enlarged swollen scales; 8/9 swollen scales covering inferior surface of fourth finger, 8/9 covering fourth toe; subapical plates very large, much wider than more proximal width of digit; nail very short, strongly curved, not projecting distally beyond claw sheath; tail regenerated—very short and bulbous, covered with large swollen square scales forming regular annuli (plate 34, B); male; cloacal spur consists of cluster of 7/6 sharply pointed strongly projecting spines; preanal pores absent.

Dorsal ground colour reddish-brown; dorsal surface of head uniform light brown; dark brown postocular stripe very conspicuous, ending abruptly above ear opening; vertebral region of body white, projecting laterally in form of serration, bordered by dark brown (pl. 34, B); dorsal surfaces of fore limbs almost uniform light brown, obvious irregular dark brown spots on dorsal surfaces of hind limbs; throat region immaculate white, all other ventral surfaces sparsely covered with brown chromatophores, most heavily concentrated on palms and soles.

Snout-vent length 60.5 (all measurements given in millimeters); length of tail 27.2; length of head 17.1; length of snout 6.2; diameter of orbit 4.4; distance between eye and ear 5.8; width of head 11.3; distance between axilla and groin 27.8; length of fore limb 23.3; length of fourth finger 4.9; length of hind limb 29.4; length of fourth toe 5.3.

Variation: In addition to the holotype, *Diplodactylus mitchelli* is known from the North West and Pilbara Divisions from the following specimens: (*a*) U.W.A. (uncatalogued), Shothole Canyon, 12 miles north-northwest of Learmonth, North West Cape, (*b*) S.A.M. R4280 and W.A.M. R14824, Coolawanyah homestead, and (*c*) S.A.M. R4281, at waterhole in Tambrey Creek at Tambrey homestead. These specimens agree with the holotype in all important characters and exhibit the following variation: rostral slightly more than twice to more than two and one-half times wider than high; dorsomedian rostral crease absent to one-fourth total height of rostral; two supranasals and one to four, avg. 2.3, postnasals; scales immediately posterior to supranasals moderately large and flat; ten to thirteen, avg. 11.3, scales between postnasals and preocular granules; seven to eight, avg. 7.4, supralabials, equal or slightly decreasing in height posteriorly; twenty-four to twenty-eight, avg. 25.5, scales between centrolateral margins of orbits; one to four, avg. 2.5, spinose scales on posterior border of dorsal eyelid; nine to eleven, avg. 10.4, infralabials; postmentals only slightly enlarged to very large and flat; mid-dorsal surface of body covered with moderately large to very large, slightly swollen or plate-like scales, one and one-half to three times larger than ventrals; seven to nine, avg. 8.0, swollen scales covering inferior surface of fourth finger, eight to ten, avg. 9.1, covering fourth toe; tail of specimen from North West Cape unregenerated—relatively short, slightly swollen, dorsal surface covered with large oval slightly imbricate or juxtaposed scales forming regular annuli, subcaudals more flattened and imbricate (tails of all other specimens absent or regenerated and similar to holotype); W.A.M. R14824 juvenile female, remaining specimens adult males; cloacal spur in males consists of cluster of seven to ten, avg. 8.2 spines; dorsal ground colour yellow to dark reddish-brown; postocular stripe absent; vertebral region of body white with lateral serration or an overall reticulation; dark brown spots either present or absent on dorsal surfaces of fore and hind limbs; ventral surfaces of body and limbs with or without sparse covering of brown chromatophores; tail of North West Cape specimen with light brown reticulation similar to dorsum of body.

Relationships: The specific relationship of *mitchelli* within the *vittatus* species group is not clear. Superficially, *mitchelli* appears to be most closely related to *vittatus*, however, there are obvious similarities to both *galeatus* and *tessellatus*.

Etymology: This species is named in honour of Mr. F. J. Mitchell, who collected the holotype and who has made many valuable contributions to Australian herpetology.

Diplodactylus savagei sp. nov.

Holotype: W.A.M. R14369. Collected at Marble Bar, Pilbara Division, Western Australia, by Glen M. Storr on 22 September, 1960.

Diagnosis: *Diplodactylus savagei* can be distinguished from all other members of the *vittatus* species group by the following combination of characters: (*a*) rostral large and hexagonal, (*b*) rostral crease absent, (*c*) anterior nasal present (rostral excluded from nostril), (*d*) only anterior-most supralabial enlarged (not in contact with nostril), all other labials replaced by granules, (*e*) dorsal eyelid undifferentiated, (*f*) spinose scales on posterior border of ocular orbit absent, and (*g*) colour pattern of large irregular white spots (plate 35, A).

Description of holotype: Head moderately depressed; eye small; snout relatively long; rostral very large, hexagonal, slightly less than twice as wide as high; dorsomedian rostral crease absent; nostril large, directed dorsally, surrounded by anterior nasal (rostral excluded), single supranasal and four postnasals; anterior nasal very large, borders first supralabial; supranasal large, meets counterpart on midline (internasal absent); scales of snout small and conical, 11/13 between postnasals and preocular granules (left and right sides respectively); anterior-most supralabial large, remaining labials replaced by 19/20 small granules; 32 scales between centrolateral margins of orbits (including those of dorsal eyelid); dorsal eyelid undifferentiated; spinose scales on posterior border of ocular orbit absent; mental very large, slightly more than twice as wide as long, bordered by seven scales (including first infralabial granule); infralabials absent, replaced by 26/26 small granules; scales bordering mental moderately large, gradually grading into conical granules of throat region; external ear opening inconspicuous, represented by small depression slightly below angle of jaw; dorsal and lateral surfaces of head and body covered with small conical granules (plate 35, A), equalling size of moderately imbricate ventrals; limbs covered with small slightly imbricate conical granules; digits moderately short and broad, very depressed; subdigital surfaces covered with two rows of enlarged swollen scales (plate 35, B); 6/7 transverse series of swollen scales covering inferior surface of fourth finger, 6/6 covering fourth toe; subapical plates large, slightly wider than more proximal width of digit; nail short, strongly curved, not projecting distally beyond claw sheath; tail regenerated; male; cloacal spur consists of cluster of 12/11 sharply pointed strongly projecting spines; preanal pores absent.

Dorsal ground colour dark brown; large irregular white spots randomly scattered over dorsal and lateral surfaces of neck and body (plate 35, A); *canthus rostralis* and supralabial margin white; interorbital and occipital regions covered with irregular white marks; some indication of small white spots on dorsal surfaces of limbs; ventral surfaces of head and body immaculate white, devoid of chromatophores; ventral surfaces of limbs covered with some chromotophores, becoming heavily concentrated on palms and soles.

Snout-vent length 42.7 (all measurements are given in millimeters); length of head 8.2; length of snout 3.8; diameter of orbit 2.0; distance between eye and ear 2.4; width of head 6.5; distance between axilla and groin 20.7; length of fore limb 13.8; length of fourth finger 2.6; length of hind limb 14.5; length of fourth toe 3.2.

Variation: In addition to the holotype, *Diplodactylus savagei* is known from the Pilbara Division from the following specimens: (*a*) S.A.M. R3464 (2 specimens) Pilgangoora Well and (*b*) S.A.M. R4282 Coolawanyah homestead. These specimens agree with the holotype in all important characters and exhibit the following variation; rostral slightly less to more than twice as wide as high; four to six, avg. 4.5, postnasals; anteriornasal and supranasal separated from counterparts by one to two, avg. 1.3, internasals; fourteen to fifteen, avg. 14.2, scales between postnasals and preocular granules; fifteen to seventeen, avg. 16.2, granules bordering supralabial margin; thirty-one to thirty-six, avg. 33.0, scales between centrolateral margins of orbits; mental slightly less than twice as wide as long, bordered by five to six, avg. 5.3 scales; twenty-five to twenty-seven, avg. 26.5, granules bordering infralabial margin; external ear opening very small; scales covering dorsal and lateral surfaces of head and body slightly imbricate; six to seven, avg. 6.7 transverse series of swollen scales covering inferior surface of fourth finger, seven to nine, avg. 7.8, covering fourth toe; tails absent; all females; cloacal spur consists of a cluster of five to fourteen, avg. 9.7, slightly enlarged soft scales; moderately large irregular white spots distinct or beginning to become confluent; only faint indication of chromatophores on palms and soles.

Relationships: *Diplodactylus savagei* appears to be closely related to *conspicillatus*. This assumption is inferred from their similar rostral shape and absence of a rostral crease, type and arrangement of scales bordering the nostril, absence of enlarged labials, undifferentiated dorsal eyelid, absence of spinose scales on posterior border of ocular orbit, and size and shape of mental. *Diplodactylus savagei* can be distinguished from *conspicillatus* by the size of its subapical plates and the size and arrangement of its infradigital lamellae (plate 35, B) and its colour and colour pattern (*conspicillatus* is a marbled brown). In the Pilbara Division *conspicillatus* has been collected at Yandeyarra and Mundabullangana Stations.

Etymology: This species is named in honour of Dr. Jay M. Savage, whose interest in herpetology has stimulated all those students who have come in contact with him.

DESCRIPTIONS OF PLATES 34-35

PLATE 34

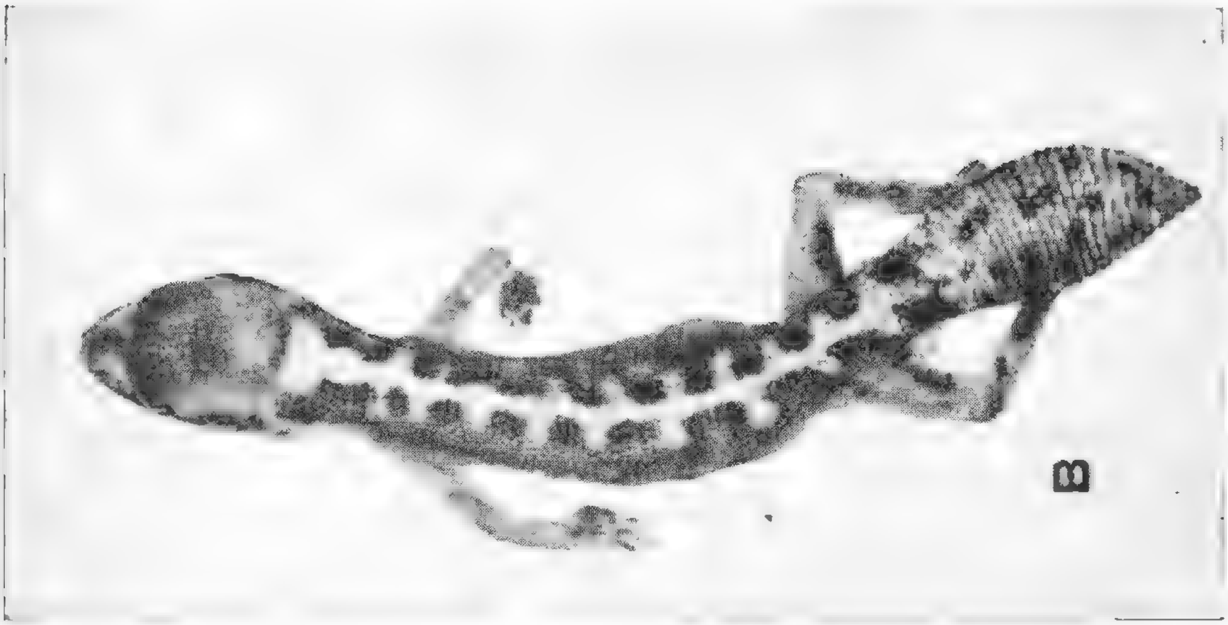
A. A dorsal view of the holotype (S.A.M. R973) of *Diplodactylus galeatus*.

B. A dorsal view of the holotype (W.A.M. R14823) of *Diplodactylus mitchelli*.

PLATE 35

A. A dorsal view of the holotype (W.A.M. R14369) of *Diplodactylus savagei*.

B. A ventral view of the fourth toe showing the comparative sizes of the subapical plates and subdigital lamellae of *Diplodactylus conspicillatus* and *Diplodactylus savagei* (right).



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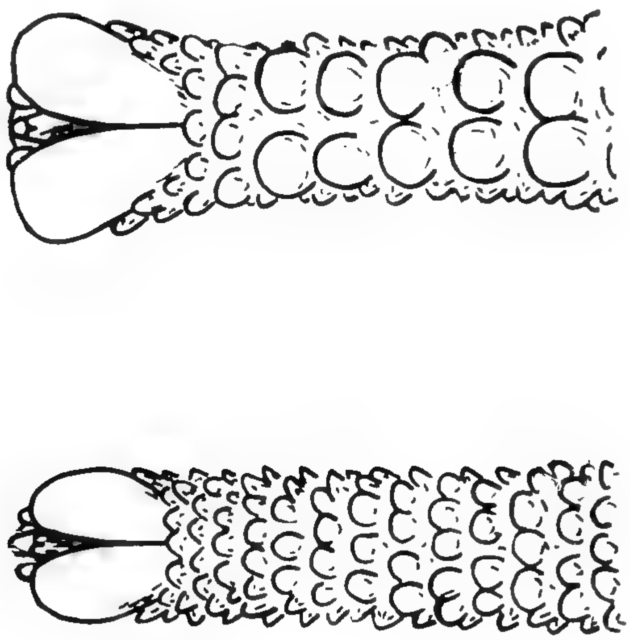

B

A

A TJURUNGA-LIKE STONE PENDANT FROM NEW SOUTH WALES

BY NORMAN B. TINDALE, CURATOR OF ANTHROPOLOGY, SOUTH AUSTRALIAN MUSEUM

Summary

This paper records a stone tjurunga-like object or pendant with carved designs, from Coolamon in the Albury district, New South Wales. The finding also of portion of a stone tjurunga, without markings, from the Boulia district of Queensland is reported

In July 1960 the Rev. H. K. Bartlett drew my attention to the report of the finding of a stone tjurunga-like object, by Mr. William Eisenhauer, while he was slashing burrs on his father's property at "Bonnie Doon", three miles west of Coolamon, in the Albury district of New South Wales.

A TJURUNGA-LIKE STONE PENDANT FROM NEW SOUTH WALES

By NORMAN B. TINDALE, Curator of Anthropology, South Australian Museum

Fig. 1-4

SUMMARY

This paper records a stone *tjurunga*-like object or pendant with carved designs, from Coolamon in the Albury district, New South Wales. The finding also of portion of a stone *tjurunga,* without markings, from the Boulia district of Queensland is reported.

INTRODUCTION

In July 1960 the Rev. H. K. Bartlett drew my attention to the report of the finding of a stone *tjurunga*-like object, by Mr. William Eisenhauer, while he was slashing burrs on his father's property at "Bonnie Doon", three miles west of Coolamon, in the Albury district of New South Wales. A photograph showed the specimen to be of interest and Mr. Bartlett, having corresponded with Mr. Eisenhauer, received it as a gift in January 1961. In July 1962 he presented the specimen to the South Australian Museum, where it is now registered as No. A.54131. The specimen is described herein. Opportunity also is taken to record another stone *tjurunga*-like object from the Boulia district of Queensland (fig. 1-2).

DESCRIPTION

The Coolamon specimen (fig. 3-4) is fashioned from a natural pebble of indurated gritty mudstone, reddish-brown in colour, both on the weathered surface and below it; broken places show there is little change of colour within the stone. The specimen has been lying in the surface soil of land which has been ploughed periodically for some years and bears score marks either of tines or of plough shares which have passed over it and mutilated parts of the surface, fortunately without seriously interfering with rather deeply incised designs carved on its surfaces. The length of the stone is 17.3 cm., its greatest width is 5.0 cm. and its general thickness ranges between 1.9 and 2.2 cm.

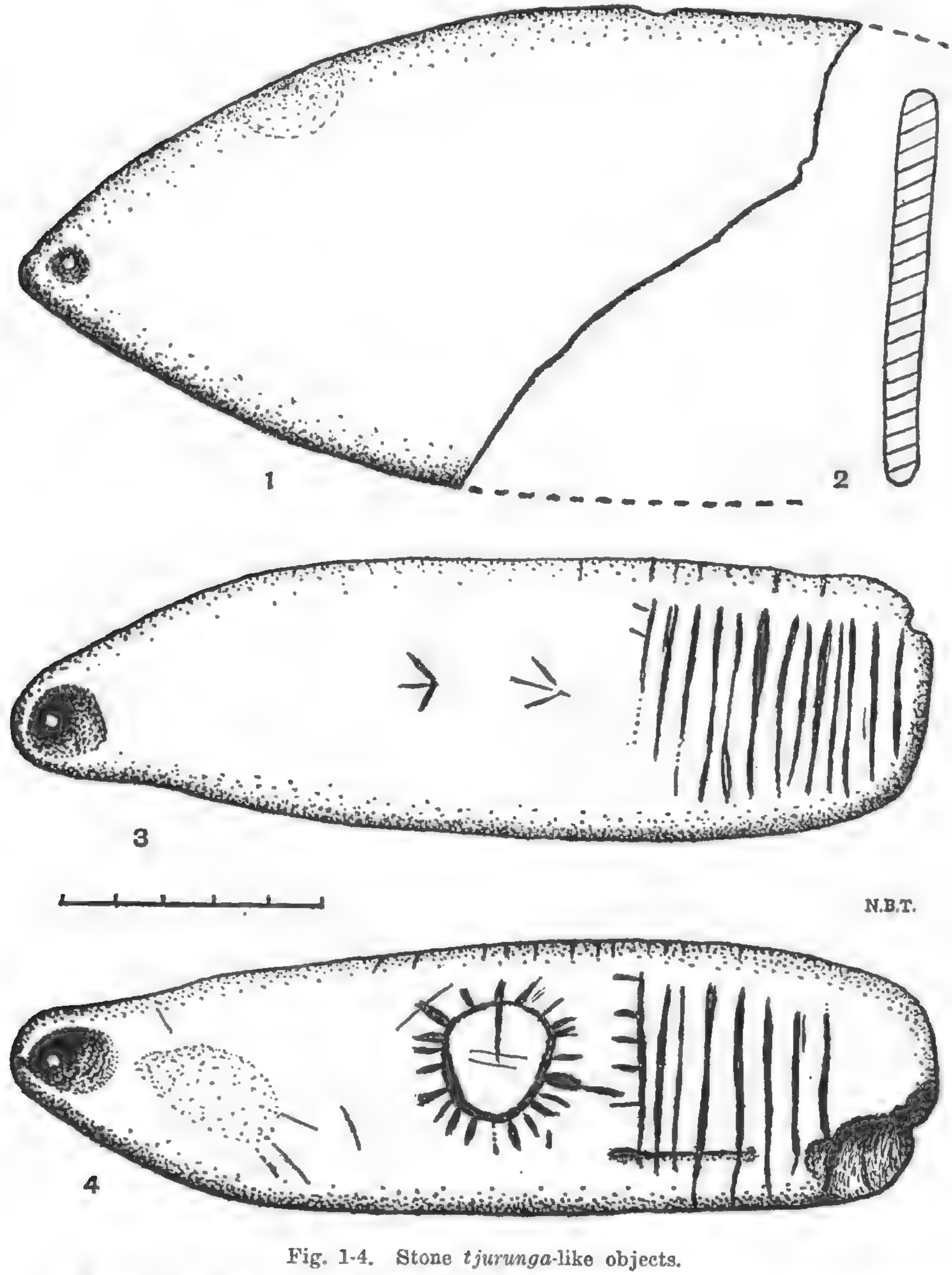

Fig. 1-4. Stone *tjurunga*-like objects.

1. Portion of an example from Boulia River, Queensland (specimen in Nielsen Collection).
2. Transverse section through it.
3-4. Two faces of specimen from Coolamon, New South Wales (specimen A.54131 in S.A. Museum). Scale is to be read in centimeters.

The pebble from which it was fashioned had rounded margins and tapered to one extremity where, in manufacture a hole was drilled by boring cup-shaped depressions from each side until they met in the middle of the substance of the stone. The diameter of this circular hole is 2.4 mm. In drawing the accompanying illustrations (fig. 3 and 4) the superficial injuries caused by plough marks have been ignored. The effects were chiefly confined to abrasion and incisions affecting the continuity of the transverse marks; where the original lines have been obscured or lost the missing portions are indicated by dotted lines. The damage in no way affects the interpretation of the markings. The margin distant from the pierced hole has received some damage; this probably was done before its defacement by the plough. Designs from the two surfaces are shown in the illustrations; these are reproduced at about two-thirds natural size; the scale with the drawings should be read as indicating centimetres. The markings on the stone are rather crudely incised, varying in depth of cutting from slight scratches to scorings up to 2 mm. in depth. The deepest cutting is in the circular figure with its radiating lines. The lateral margins bear faint well-worn traces of short incisions; these are placed not quite symmetrically in mid-line, so that viewed from a flat face they tend to be visible only on one of the two lateral margins. The exception is that at least three of the long transverse lines on the face with the circular design continue faintly over the edge to link with those faint marginal notches, which otherwise chiefly are visible from the opposite face and from the side.

Recently (September 1962) a visit was made to Lake Menindee with Dr. R. Tedford and Mr. G. Pretty. At Menindee township Mr. J. H. Nielsen showed me a broken portion of a stone *tjurunga* in his collection (fig. 1-2). It is made from a smooth, fine-grained sandstone of dark colour, is without ornament, but has been pierced with a hole at one extremity. As in the Coolamon example, this hole was bored by drilling in from both surfaces, until the holes met in the middle. The locality given for the specimen was Boulia River, Queensland; it remains in Mr. Nielsen's possession.

The length of the preserved portion of the Boulia specimen is 15.1 cm., its greatest diameter being 8.8 cm., and its thickness 0.7 cm. When intact the *tjurunga* may have been about 25 cm. in length with a maximum width close to 9 cm. The general thickness was rather uniform suggesting that the sandstone from which it was made is of a rather regularly fissile nature.

DISCUSSION

The use of the term *tjurunga* in association with the stone pendant from Coolamon, New South Wales, relates purely to its physical form. It is *tjurunga*-like but it could conceivably once have been either an ornamental pendant or an object of magical significance. Because of its thickness it does not seem effective as a sound-making bull-roarer and would be clumsy if swung in the fashion of such an instrument. When first mentioned in the press report it was regarded as a form of cylindro-conical stone.

It is rather a crudely conceived object made on a natural pebble of rather soft mudstone. It has been drilled for suspension by a cord or string.

The designs on it were possibly engraved with a piece of stone, using a sawing action; the cuts often suggest multiple to and fro movements of the tool with occasional change of position or perhaps alteration to edge of the incising tool by fracturing, leading to variations in the scratches in the grooves.

The parallel series of incised lines cut on it are similar to ones on some cylindro-conical stones from the Darling River district and also match others found on flat slate pebbles, from the Flinders Ranges, South Australia, such as have been recorded principally by Cooper (1947, 1954).

The bird tracks depicted are similar to ones found on wooden weapons, on slate scrapers, as rock carvings in many places, and as tracks painted in rock shelters. Because they depict and symbolize usually specific birds there is not much reason for stylistic departure from actual tracks. No attempt has been made to identify the specific bird registered by the tracks.

The circular figure with radiating lines which is a prominent feature of the stone is very reminiscent of a large carving present on the roof of Devon Downs rock shelter in South Australia, as may be noted by comparing it with the figure published by Hale and Tindale (1930, fig. 246). Descriptively this was called a "sun" design, following the conventions of our own culture. A Maraura tribe aboriginal, in 1938, drew a design reminiscent of it while telling a story about Eagle and the Crow. His version is figured by Tindale (1939, p. 256, fig. 5). It there happened to represent men sleeping around a magic tree. It would appear that the design could have had any one of a number of interpretations; one suggestion from our own culture is that it possibly is intended to depict female genitalia.

The specimen from Boulia River is not critically localized; it was received by Mr. Nielsen indirectly from a third party. It may suggest an eastward extension of the use of *tjurunga*-like stone objects and records the employment of a stone type other than the phyllitic material favoured by Aranda, Kukatja and kindred people of the MacDonnell Ranges.

ACKNOWLEDGMENTS

We are indebted both to Rev. H. K. Bartlett for his efforts on our behalf and to Mr. Eisenhauer for consenting to have the specimen lodged in the Museum collection.

Mr. J. H. Nielsen kindly permitted the examination of his collection and assisted us in other ways.

Opportunity is taken to note the several courtesies extended to us by Mr. N. O. Farrar of Bootingee Station, by Mr. R. May and by Mr. G. Packer, on whose land we collected specimens during our visit to Lake Menindee district. Mr. A. L. Blight reported to us several archaeological and palaeontological finds which are now being studied.

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YOUNG FEMALE PIGMY SPERM WHALES (KOGIA BREVICEPS) FROM WESTERN AND SOUTH AUSTRALIA

BY HERBERT M. HALE, HON. ASSOCIATE,
SOUTH AUSTRALIAN MUSEUM

Summary

Kogia breviceps is recorded from Western Australia for the first time. Also, a juvenile female from South Australia is described; this has a conspicuous bracket-like marking behind the eye, considered by some to be a characteristic of the genus, and differs considerably in skeletal characters from the western young female.

YOUNG FEMALE PIGMY SPERM WHALES (KOGIA BREVICEPS) FROM WESTERN AND SOUTH AUSTRALIA

By HERBERT M. HALE, Hon. Associate, South Australian Museum

Plates 36-41 and text fig. 1-11

SUMMARY

Kogia breviceps is recorded from Western Australia for the first time. Also, a juvenile female from South Australia is described; this has a conspicuous bracket-like marking behind the eye, considered by some to be a characteristic of the genus, and differs considerably in skeletal characters from the western young female.

INTRODUCTION

I am indebted to my friend Dr. W. D. L. Ride, Director of the Western Australian Museum, for the opportunity of describing a young female *Kogia* from the south-west coast of Australia and also for the information concerning it recorded below.

On the evening of September 18, 1959, two men observed a school of "porpoise-like animals" in the neighbourhood of Leighton Beach, near Fremantle, the port of Perth, in Western Australia. At 10 a.m. on the following day passers by saw a small whale ashore and still alive on the Leighton Beach. Mr. N. Steward reported the occurrence to Dr. Ride who, with some members of his staff, collected the specimen at 4 p.m. on the same day—September 19, 1959. It proved to be a female approximately 220 cm. in length. A fibre-glass cast of the whale and its skeleton are preserved in the Western Australian Museum.

In the small hours of the morning of September 12, 1961, a young female Pigmy Sperm Whale, reported by some observers as a "porpoise", or the calf of a Humpback seen swimming nearby, was stranded on a soft sandy beach, two miles north of Grange, on the eastern side of St. Vincent Gulf, South Australia. This *Kogia* was photographed by the press on the same morning, and I am indebted to

The News and *The Mail* of Adelaide for the photograph reproduced on plate 36, B. Soon afterwards the whale was brought to the Museum by members of the staff. It exhibited no barnacle scars, but numerous recent short cuts were present on the lateral and, particularly, ventral surfaces, possibly caused by the nearby extensive *Pinna* beds.

This example came ashore during calm weather. Its complete skeleton is housed in the South Australian Museum.

As with other small whales, kogias are sometimes referred to by casual observers as "blackfish" (for example see Gunther, Hubbs and Beal, 1955, p. 263 and 269; also Hale, 1959, p. 337) or "porpoises" (Manville and Shanahan, 1961, p. 270), one of the reasons why strandings are not always immediately reported and, indeed, probably often disregarded.

WESTERN AUSTRALIAN FEMALE, APPROXIMATELY 220 cm. IN BODY LENGTH (W. AUST. MUS. REG. NO. M.4519).

External Characters

According to measurements kindly supplied by Mrs. Kaye Thies of the Western Australian Museum, and to photographs taken by Dr. Ride of the animal on the beach, the snout was very short, about 2.0 per cent in the body length, while the dorsal fin was situated a little anterior to the middle of the body length. The greatest length of the pectoral limbs was about three times that of the width.

The snout was blunt and deep, rounded above and descending steeply and only slightly obliquely, before curving back only a short distance above the most anterior point of the mouth (pl. 36, A and text fig. 1). As already suggested (Hale, 1962, p. 200) a relatively short snout and small skull account for a more forward position of the dorsal fin in relation to the body length. Yamada's measurements (1954, pp. 41 and 45) of a Japanese female, 2,200 mm. in length, indicate that this had a short snout, the origin of the dorsal fin in advance of the middle of the body, and the skull less than one-eighth of the body length.

As shown by Dr. Ride's photographs the blowhole was semicircular and obliquely inclined towards the rear, terminating on the right side at a distance from the snout considerably greater than in the case of the left end.

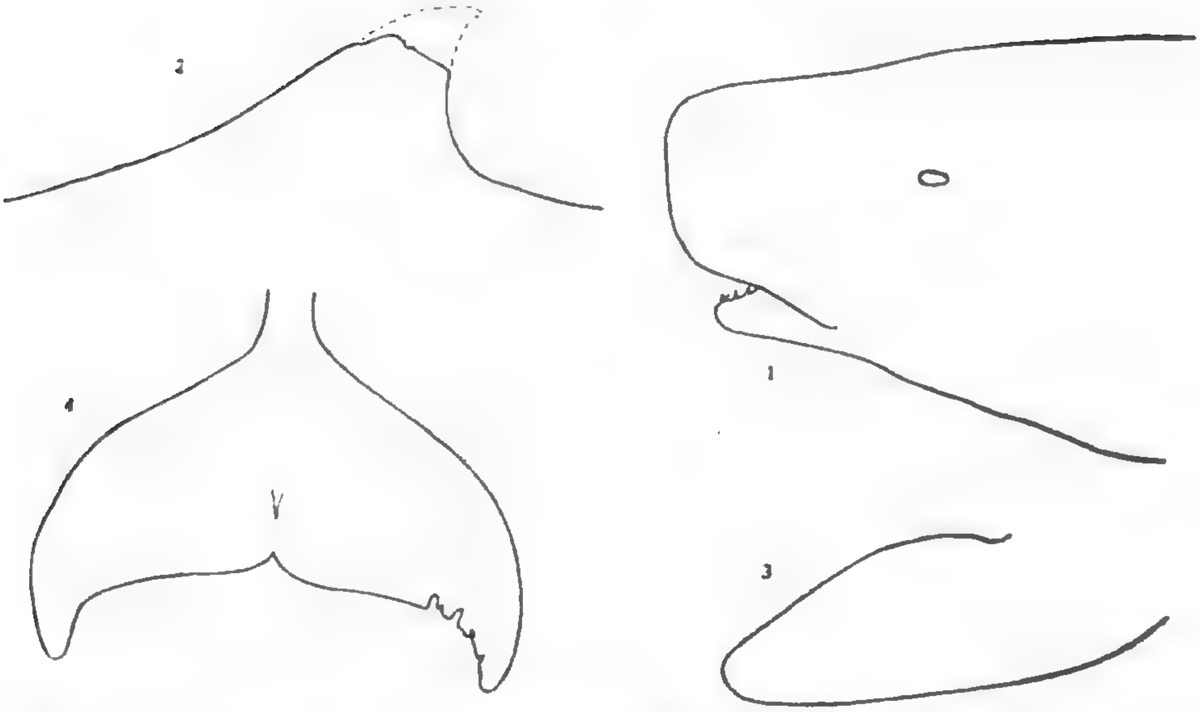

Fig. 1-4. Young female, near Fremantle, Western Australia; 1, head; 2, mutilated dorsal fin; 3, pectoral limb; 4, caudal fin (not to same scale).

According to the photographs the dark dorsal colour extended down to occupy the greater part of the snout and, as seen from the side, merged into the white of the underside not far above the upper jaw. Behind the mouth the dark pigmentation was crossed by an ill-defined white streak, curving upwards to the neighbourhood of the ear; from the dorsal end of this marking an irregular streak ran towards the axilla of the pectoral limb (cf. pl. 36, A herein, and Yamada, 1954, fig. 5, b). The dark colour, as far as can be judged, occupied the whole of the dorsum and extended far down on the sides, the white of the underside, however, extending upwards to the rear of the insertion of the pectoral limb.

Skeleton

Skull (pl. 37, A and 38, A). Relatively small, more than eight times in the given body length of the animal. The rostrum, from tip to anterior wall of the left nostril, is much less than half of the total length of the skull and measured to the posterior level of the antorbital notches it is slightly less than half; it is distinctly wider than long, in fact its breadth between the antorbital processes is almost half of the total skull length.

The supraoccipital has a shallow longitudinal median depression in the dorsal half with a short median carina at the apex. Its upper margin is broadly rounded with a tiny median projection bent down between the maxillae (pl. 37, A and 39, A); the bone at its narrowest part, between the posterior borders of the temporal fossae, is less than twice its height.

The prominent occipital condyles are widely separated dorsally; ventrally they are separated by a distance equal to about one-fifth of their height.

The foramen magnum is oval in shape, its width equal to three-fourths the height.

The lateral surfaces of the maxillae are low and rounded, before descending to form the great fossae; the right (measured from the posterior end of the maxillomalar suture) is 20 mm., and the left 28 mm., in depth.

The malar on both sides is not fused with the frontals or with the maxillae. The maxillo-malar sutures form a V, deeper and more acute on the left side, and barely recurved posteriorly; they do not rise to the level of the dorsum of the antorbital processes.

The dorsal crest is only slightly elevated above the level of the supraoccipital. The right premaxilla is considerably expanded behind the nares, where it is two-ninths the length of the bone. The prefrontal forms a high crest between the nares, is elevated above the right premaxilla alongside the right nostril, and has the notch in the margin bordering this nostril V-shaped and well defined.

On the palatal surface the anterior ends of the premaxillae appear on both sides for a distance of 21 mm. and, with the vomer, reach slightly beyond the anterior ends of the maxillae. The maxillary alveolar grooves are smooth, well defined, somewhat widened anteriorly, and 58-66 mm. in length.

The postorbital processes are tapering and apically subacute while the distance between them slightly exceeds that between the antorbital processes.

The full number of teeth presumably is not available, 15 only being sent separately from the mandibles; on the whole these show greater curvature than those of a calf previously figured (Hale, 1947, fig. 10). The largest is 21 mm. in length, and all are apically acute.

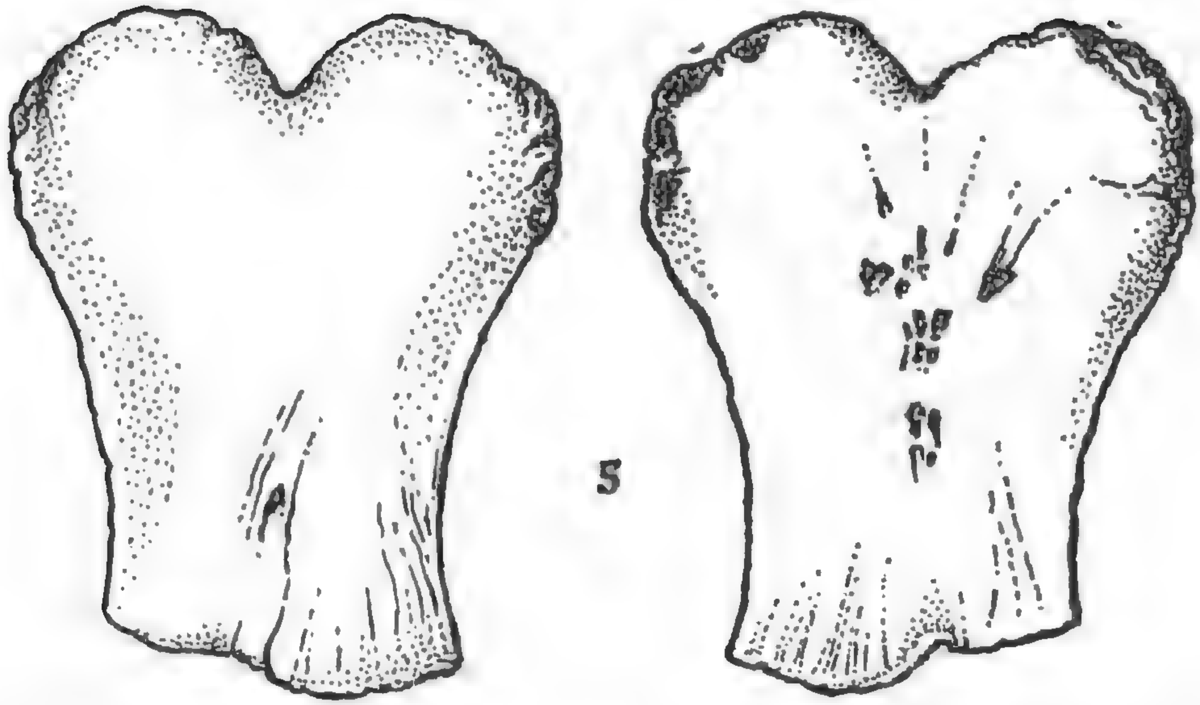

Fig. 5. Ventral (left) and dorsal views of manubrium of sternum of Western Australian young female (5/6 nat. size).

Sternum. The bony portion of the manubrium is the only component available. It is unusually narrow anteriorly, where its width is less than the length. Wing-like expansions are poorly developed in the bone but doubtless were present and cartilaginous, as evidenced by the thickness of the antero-lateral margins. No median suture or foramina are present, although indications of the latter appear on the dorsal face; see fig. 5 which shows proportions, anterior notch, etc.

Vertebrae. The cervicals (pl. 41, A and B), as is most usual in the genus, form one solid mass, the height of which (89 mm.) is less than that of the greatest width (104 mm.); the spinous process is low and wide as in Yamada's No. 5 example (Yamada, 1954, fig. 8, upper) but unlike it has no indentations, when viewed from the side, near the obtuse apex.

The first of the 13 thoracic vertebrae, like all the others, has the neural arch complete, its neural canal is not much wider than deep and its dorsal spine is apically subacute, inclined forwards, and is two-sevenths the total depth of the vertebra. The second thoracic spine is also slightly forwardly inclined and tapers to a subacute apex. The dorsal process of the last thoracic, measured from the upper limit of the neural canal, is one-fifth longer than the distance between the venter of the centrum and the apex of the canal, and more than one-half of the depth of the vertebra (pl. 41, C and D). The apex of the dorsal process is subtruncate and more or less slightly convex in the second to ninth thoracics, subtruncate and slightly concave in the last three.

In the anterior five of the nine lumbar vertebrae the dorsal spine is also more than half the total depth of the vertebra; in the sixth and seventh it is subequal, and in the eighth and nine a little shorter. The neural canal from the tenth thoracic, and in all the lumbars, is approximately twice as deep as wide, although a progressive reduction in the size of the canal begins with the first lumbar.

The anterior fifteen of the caudal vertebrae are available, the rest being *in situ*, as the caudal fin as well as other parts, were preserved by Dr. Ride. Metapophyses are paired on the first four, are fused on the fifth and, as an anterior projection, do not entirely disappear until the eleventh caudal, but as usual become successively shorter. The neural canal becomes a wide, open groove on the fourteenth and fifteenth.

The epiphyses are completely free on the posterior face of the cervicals and on both faces of the centrum of all the remaining vertebrae available.

Only eleven chevrons, all with the members united, accompany the disarticulated skeleton.

Ribs. Thirteen pairs, the anterior eight with a double articulation.

Length of ribs taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	210	212
2	281	285
3	305	315
4	322	322
5	323	325
6	316	316
7	Tip abraded	315
8	280	290
9	263	289
10	Tip abraded	271
11	253	260
12	232	Tip abraded
13	Dorsal end broken	192

SOUTH AUSTRALIAN FEMALE, 192 cm. IN BODY LENGTH (S.A. MUS. REG. NO. M.6310).

I am indebted to Miss M. Boyce, of the Museum staff, for the photographs reproduced on plates 37 to 41 and also for the text figures of this specimen.

Parasites and Stomach Contents

The fore and main stomachs contained an astonishing mass of worms, large and small, and beaks of small examples of the Southern Squid, *Sepioteuthis australis* (identified by Mr. B. C. Cotton, Curator of Molluscs at the South Australian Museum).

External Characters

In the photograph on pl. 36, B, the apparent depression beneath the snout is an optical illusion. The length of the body was fully four and one-half times its greatest depth. The snout was rounded, with the front curving backwards to the mouth. The crescentic blowhole was large, 50 mm. in diameter, oblique, and with the left end of

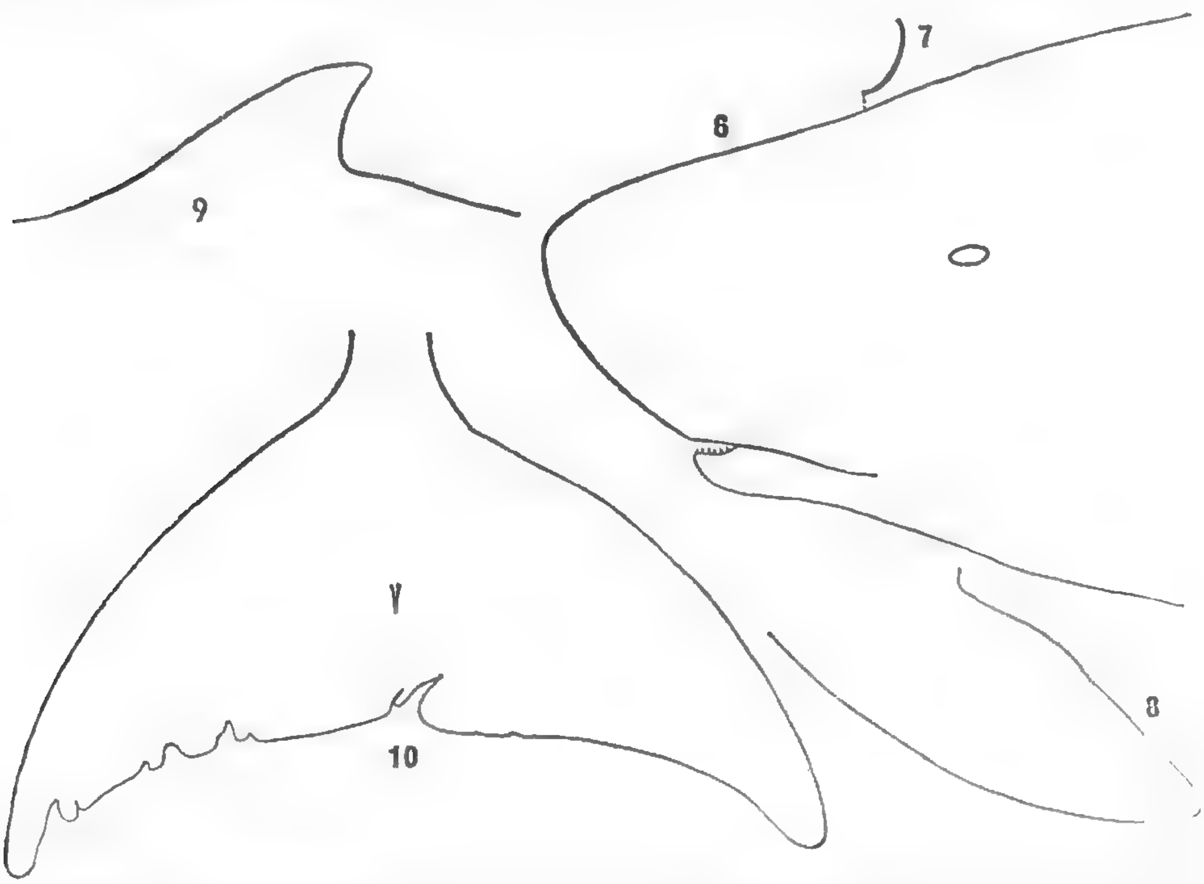

Fig. 6-10. Young female, St. Vincent Gulf, South Australia; 6, head; 7, blowhole; 8, pectoral limb; 9, dorsal fin; 10, caudal fin (all 1/6 nat. size).

the opening 205 mm., from the vertical level of the snout, that of the right 230 mm. (fig. 6-7). The dorsal fin was three times as long as high and situated slightly in advance of the middle of the length (fig. 9).

When first stranded the colouration was as follows. Grey on upper part of snout, the dark area extending back to three inches below the eye, thence to the axilla of the pectoral fin. The white of the underside extended upwards, however, to form a bracket-like marking behind the eye (exactly as in the photographs of a Californian adult published by Hubbs, 1951, p. 406, pl. 3) and again beneath the pectoral fin in the form of an almost circular patch, which was margined dorsally with grey as dark as that of the back of the animal. The grey otherwise extended from the axilla to beyond the anus, when it curved down, leaving only a small part of the underside of the base of the tail white.

The pectoral fins were dark grey externally and on the inner edges. The caudal flukes were dark grey above, the underside with the edges margined with similar colour and the remainder white with irregular dark spottings.

The bracket-like marking and the patch behind the pectoral fin had become pinkish, but were still discernible, 48 hours after the animal was stranded.

Body Measurements.

Measurements.	mm.	per cent.
Total length to notch of tail flukes	1,920	100
Greatest depth of body	430	22.4
Tip of snout to vertical level of anterior corner of eye	250	13.0
Tip of mandible to vertical level of anterior corner of eye	160	8.3
Tip of snout to most anterior point of blowhole	205	10.6
Tip of snout to vertical level of anterior end of base of dorsal fin	965	50.2
Tip of mandible to axilla of pectoral limb	420	21.8
Tip of mandible to anterior point of vulva	1,200	62.5
Tip of mandible to anterior point of anus	1,250	65.1
Length of gape to posterior fold	113	5.8
Length of eye	25	1.3
Depth of eye	12	0.6
Greatest width of caudal flukes	510	26.5
Height of dorsal fin	95	4.9
Length of base of dorsal fin	315	16.4
Greatest length of pectoral fin	290	15.1
Greatest width of pectoral fin	105	5.4

Skeleton

Skull (pl. 37, B to 39, B). This is less than one-seventh of the body length. The rostrum, from tip to anterior wall of the left nostril, is less than half the length of the skull but measured to the posterior level of the antorbital notches is more than half. The skull is about as wide as long, and its greatest breadth, between the antorbital processes, is distinctly more than half its length.

The supraoccipital has a shallow median depression near the vertex only. Its upper margin is produced and broadly triangular medianly, a feature apparent in pl. 38, B, but, because of its forward inclination not evident in pl. 39, B; the width of the bone, at its narrowest part, between the posterior borders of the temporal fossae, is more than twice its height.

The frontal is free for the whole of its visible length, while the shape of the squamosal (as compared to that of the Western Australian example) is best illustrated by reference to pl. 38.

The occipital condyles are elongate, widely separated dorsally, and ventrally by a distance equal to less than one-seventh of their height.

The foramen magnum is as wide as deep.

The dorsal edges of the maxillary fossae are sharply defined ridges (pl. 37, B). The lateral surfaces of the maxillae very considerably in height, as measured from the posterior end of the maxillo-malar suture, being on the right side 25 mm. and on the left 45 mm. in depth.

The malar on both sides shows no indication of fusion with the maxillae or frontals. The maxillo-malar suture forms a shallow U on both sides, recurved downwards to frontal and anteriorly rising to above the level of the dorsum of the antorbital processes.

The dorsal crest is elevated a little above the level of the supra-occipital. The expanded portion of the right premaxilla, posterior to the nares, is at its widest part one-fifth of the length of the bone.

In the palatal region the anterior ends of the premaxillae appear for a length of 20 mm., and reach slightly beyond the anterior ends of the maxillae. The alveolar grooves, smooth and well defined, are 90 mm. in length on both sides.

The subtriangular and apically narrowly rounded postorbital processes are wider than in the Western Australian female (pl. 38); the width between them is distinctly more than the breadth of the skull between the antorbital processes.

No upper teeth are present; there are 15 teeth in the left ramus of the lower jaw, 16 in the right; the longest teeth are 16 mm. in length, and all are apically acute. As in the western specimen the rami are not fused at the symphysis.

Tongue bones (pl. 40, A). The basihyal is roughly hexagonal in shape and wider than long; the anterior margin has a shallow median notch, on both sides of which is a relatively wide articular area, to which is attached a short cartilage, articulated with the cartilaginous ceratohyal; the posterior part has a distinct angular notch on each side, near the concave posterior margin. The bony portions of the stylohyals are considerably longer than the ceratohyals or the thyrohyals. The latter are irregularly oval in shape and surrounded by cartilage, which separates them very markedly from the basihyal.

Sternum (pl. 40, B, ventral view). This consists of four segments, the first three of which are entire. The ossified part of the manubrium is not much wider than long, with a narrow and short median notch at the anterior edge; thick oval portions, 18 mm. and 22 mm. in length, are fused antero-laterally with the main body of the manubrium (fig. 11); the ragged suture of the left, and larger, suggests that at least this element was previously separated from the rest of the manubrium (cf. also Hale, 1962, pl. 4, fig. A and B, where these parts are cartilaginous); the wing like expansions of the anterior half are well developed and the posterior margin has a shallow median notch, alongside which the articular surfaces slope forwards. The second and shorter segment, as in the posterior half of the manubrium, has markedly concave sides; the third segment, likewise with concave

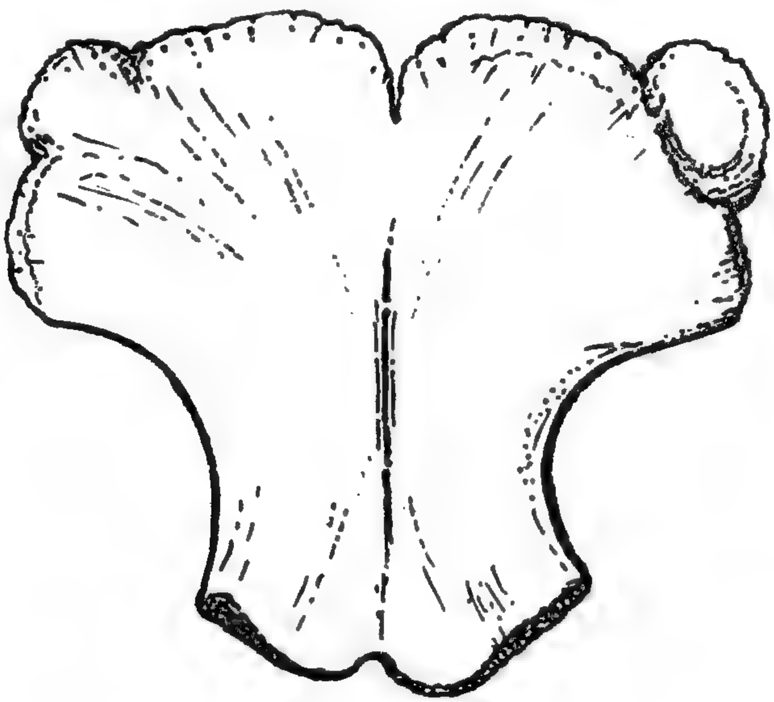

Fig. 11. Ventral view of manubrium of sternum of South Australian young female (5/6 nat. size).

sides, is four-fifths the length of the second and less than half the length of the manubrium (85: 50: 40). As in a young male from South Australia there is a fourth small segment, but in this young female only the element of the right side is ossified (cf. Hale, 1962, pl. 4, A and pl. 40, B herein).

Vertebrae. Counted *in situ,* with the animal partly fleshed, these are: cervical, 7; thoracic, 13; lumbar, 9; caudal, 25—a total of 54.

The first caudal is regarded as that in which the anterior corners of the first chevrons are attached to the hinder end of the centrum. The last two caudals are very small.

In other young examples from South Australia the vertebrae (counted in like manner) range from 53 to 57 and in adults 52-55.

The height of the cervical mass is less than the width (86: 100); the dorsal process is short, narrow in cranial view, and seen from the side is apically rounded and with two shallow notches in the anterior margin (pl. 41, E and F).

All the thoracic vertebrae have the neural arch complete; the first has the neural canal wider than deep (37: 25), and its dorsal process very short, less than one-sixth the depth of the vertebra. The second thoracic has a much longer dorsal process but still falling far short of that of the western female. In the succeeding thoracics the dorsal process becomes successively longer; the dorsal process of the last (thirteenth), measured from the upper limit of the neural canal is only half the depth of the vertebra, its width is four-sevenths its length, and as with the other thoracics the apical margin is subtruncate and convex (pl. 41, G and H).

In the nine lumbar vertebrae the dorsal process is similar to that of the thoracics in shape; in the first the process is one-half the depth of the vertebra, in the others less than half, the ratio in the ninth being 40: 108.

The neural canal becomes progressively smaller from the fifth thoracic vertebra; it is wider than deep in the first four but posterior to the fourth is deeper than wide (21: 18 in the thirteenth; pl. 41, G and H); in the ninth lumbar the depth of the canal in relation to its width is 15: 8.

In the 25 caudal vertebrae metapophyses are paired on the first four, fused on the fifth, and are distinguishable as an anterior projection until the ninth. The neural canal becomes a completely open groove on the thirteenth. The last two caudals are extremely small, being, without the epiphyses, 4 mm. and 2 mm. in length.

The vertebral epiphyses are quite free on the posterior face of the cervicals and on both posterior and anterior faces of the centrum of all other vertebrae.

There are 13 chevrons, all the members united excepting in the last pair.

Ribs. Thirteen on both sides, the last pair rudimentary; they were counted before dissection of the animal was completed, the eight anterior pairs have a double articulation.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	155	153
2	230	230
3	265	264
4	275	280
5	287	282
6	287	283
7	279	275
8	265	264
9	249	253
10	230	231
11	210	212
12	182	186
13	25	33

Skull measurements of the two young females.

Measurements.	Western Australia (M.4519).			South Australia (M.6310).		
	mm.	Per cent length.	Per cent breadth.	mm.	Per cent length.	Per cent breadth.
Total condylobasal length	263	100.0	113.8	270	100.0	108.0
Height to vertex	166	63.1	71.8	170	62.9	68.0
Width between postorbital processes	231	87.8	100.0	250	92.6	100.0
Hinder edge of occipital condyles to posterior wall of left naris	134	50.9	58.0	130	48.1	52.0
Height of supraoccipital from upper margin of foramen magnum	95	36.1	41.1	86	31.8	34.4
Width of supraoccipital at narrowest part between posterior margins of temporal fossae	161	61.2	69.7	172	63.7	68.8
Length of rostrum from tip to anterior wall of left naris	109	41.4	47.1	125	46.3	50.0
Tip of rostrum to anterior margin of palatines	93	35.3	40.3	95	35.2	38.0
Width of rostrum between antorbital processes	131	49.8	56.7	145	53.7	58.0
Greatest length of pterygoids	120	45.6	51.9	130	48.1	52.0
Length of left naris	34	12.9	14.7	38	14.1	15.2
Width of left naris	22	8.3	9.5	27	10.0	10.8
Height of foramen magnum	36	13.6	15.5	34	12.6	13.6

Skull measurements of the two young females—*continued.*

Measurements.	Western Australia (M.1519). mm.	Per cent length.	Per cent breadth.	South Australia (M.6310). mm.	Per cent length.	Per cent breadth.
Width of foramen magnum	27	10.2	11.6	34	12.6	13.6
Height of occipital condyles	52	19.7	22.5	60	22.2	24.0
Width of occipital condyles	70	26.6	30.3	70	25.9	28.0
Length of right ramus of mandible (condyle to anterior end of symphysis)	234	88.9	101.3	244	90.3	97.6
Depth of right ramus at coronoid ..	70	26.6	30.3	68	25.2	27.2
Length of symphysis	32	12.1	13.8	45	16.6	18.0
Length of alveolar portion	90	34.2	38.9	97	35.9	38.8

DISCUSSION

The above table, with pl. 37 and 38, show that there is quite marked variation between the two skulls. Plate 37 illustrates the considerable difference in the maxillary fossae. In the Western Australian female these are excavate evenly to the vertex, whereas in the South Australian female the surfaces become flattened (indeed on the right slightly convex) towards the vertex, where the fossae are therefore much shallower. The premaxilla of the western skull is shorter; the malar is more acute distally and has the anterior third slender and not curved upwards to above the level of the antorbital processes, as is the case in the South Australian skull. Plate 38 illustrates also the difference in the distinctly separated maxillo-malar sutures. The posterior edge of the frontal is fused with the supraoccipital in the western skull, but is free in the other.

In the South Australian example the exposed anterior portions of the palatines are very small, whereas they occupy a very much larger area in the other skull, with which, unlike the former, they are fused.

The Western Australian female appears to be older than the southern female; this is indicated by the greater body length of the former, the fact that some of the bones of the skull have fused, and the prefrontal is longer, as also are the teeth. As noted above, however, in the former the skull is shorter in relation to the body length.

Of the juveniles previously examined by me the skull of the Western Australian example, although 20 mm. longer, in some respects resembles that of a male (S. Aust. Mus., Reg. No. 6186, Hale, 1962, p. 200), 193 cm. in length and taken in St. Vincent Gulf, South Australia; as mentioned in the description of this male the skull is relatively short. A comparison of the skeletons of these two specimens again indicates the impossibility of separating *K. simus* (Owen, 1866) as a distinct *species.*

The main differences between the skull of the abovementioned young male and the Western Australian young female are that in the latter:—a, the supraoccipital, while similar in shape, is narrower in proportion ,cf. Hale, 1962, pl. 2, C and pl. 39, A herein); b, the height to vertex is lower; c, its greatest width, between the postorbital processes, is narrower in relation to the condylobasal length; d, the rostrum, measured to level of posterior ends of antorbital notches is longer, 47.5 per cent of length of skull as against 35.3 per cent, and the lower jaw is correspondingly of greater length; e, the maxillo-malar suture is of different shape on the right side—a variable character in any case; f, the expanded part of the right premaxilla, posterior to the nares, is wider; g, the maxillary fossae are shallower.

It has been suggested that in *K. breviceps* the dorsal spine of the cervical vertebrae is much longer than in Owen's *simus* and that the spinous processes of the other vertebrae may be correspondingly long (Yamada, 1954, pp. 43 and 48, etc.). In both the abovementioned South Australian male and the Western Australian female this process is short and in general the cervical mass is similar.

In the two young females herein recorded the western specimen has the dorsal process of the cervicals wider in cranial view than that of the South Australian example and seen from the side it is broadly subtriangular instead of irregularly rounded (pl. 41, cf. A and B with E and F), while in the thoracic and lumbar vertebrae the dorsal process is distinctly longer (pl. 41, cf. C and D with G and H), and see also table below).

Locality West. Australia	Height of Dorsal Process	Height of Vertebra	Per Cent	Locality South Australia	Height of Dorsal Process	Height of Vertebra	Per Cent
Thor. 13	75	139	53·9	Thor. 13	63	128	49·2
Lumb. 2	80	153	52·3	Lumb. 2	62	126	49·2

Locality West. Australia	Height of Dorsal Process	Greatest Width of Dorsal Process	Per Cent	Locality South Australia	Height of Dorsal Process	Greatest Width of Dorsal Process	Per Cent
Thor. 13	75	29	258·6	Thor. 13	63	38	165·8
Lumb. 2	80	34	235·3	Lumb. 2	62	38	163·1

While Yamada's studies (1954) did not convince him that *simus* of Owen can be satisfactorily characterized as a second species of *Kogia* he states (p. 52) "two rather distinct types apparently do exist," but are not connected continuously by all characters.

Of the Japanese material available to him, Yamada examined in detail six specimens, of which his numbers 2 and 6 show some features of *simus*, as outlined by Ogawa in 1936-37 in an attempt to distinguish *simus* from *breviceps*. The main difference noted by Yamada is that the dorsal process of the cervical vertebrae, as suggested by Ogawa also, is much longer in *simus*, as also is this process in the thoracics, lumbars and anterior caudals (Yamada, 1954, fig. 8-10).

As noted above, the dorsal spines of the cervicals do not differ much in height in the two Australian females herein discussed, but there is a marked difference in this process in the thoracics and lumbars, as well as in the anterior caudals.

The differences in the skeletons of the two young females now described lead again to the question as to whether the Pigmy Sperm Whale migrates in small herds.

It would seem that F. T. Bullen, in the *Cruise of the "Cachalot"*, was the first to suggest that *Kogia* is not a solitary whale (see also Palmer, Journ. Mamm., 29, 1948, p. 421). According to information supplied by a whaler, Yamada's examples 4 and 5 were taken from a different school than his number 6—the last separable from 4 and 5 by some characters (Yamada, 1954, p. 52).

During June to September, 1959, schools, or possibly the same school, of small, blunt-nosed whales were seen moving slowly at the surface near the coast of Encounter Bay and in St. Vincent Gulf. In June of this year a female and calf were stranded on the beach at Encounter Bay while in September an adult male came ashore in St. Vincent Gulf. (Hale, 1962, pp. 203-211 and 216.) In these three examples the dorsal process of the thoracic and lumber vertebrae is high, as in the Western Australian young female, and likewise is more than half the total depth in the last thoracic. However, the Glenelg male has a short cervical dorsal spine (as in both of the females herein recorded) whereas in the Encounter Bay female and calf this process is distinctly higher in relation to the depth.

Dr. Ride now supplies the information that on the day prior to the stranding of the young Western Australian female a school of porpoise-like animals was observed in the vicinity.

What may be further evidence of schooling is provided by a photograph secured from a 'plane, at 500 feet, close inshore at Burleigh Heads, south of Brisbane in southern Queensland, by Mr. Robert Anthony of *The Daily News*, Murwillumbah, New South Wales. This was in January, 1962, and Mr. Anthony *in litt.* supplied the information that "the school was moving in a northerly direction in a very lazy fashion". An opinion was expressed that the animals were one of the species of Whaler Sharks (*Carcharhinus*) but my colleague, Mr. T. D. Scott, Curator of Fishes at the South Australian Museum, supplies the following comment:

"I have examined carefully the photograph and am of the opinion that the animals shown herein are definitely not Whaler Sharks. In the first place, these sharks do not travel in schools as shown in the photograph but are usually of solitary habit except in the mating season, when two or three sharks are seen together. Furthermore, the general proportions of the body, which is much shorter and deeper than the Whaler Shark and the single centrally placed dorsal fin on the back, together with the horizontal tail flukes indicate that these creatures are a species of small whale. In addition, the second dorsal fin, which is rather large in the Whaler Sharks is not obvious in the photograph. I would be quite prepared to state definitely that these animals are not sharks."

Mr. Anthony's description, and the photograph, which he sent to me, possibly constitute a record of a herd of more than a score of Pigmy Sperm Whales, all in parallel formation and moving slowly in the same direction.

If *Kogia* does in fact move from place to place in coherent small groups, the point arises as to whether or not individuals of a herd have in common a combination of some of the obviously variable characters (osteological and/or external), and that these would serve to distinguish them from members of other schools, all having an appreciable different aggregation of the variables.

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EXPLANATION OF PLATES 36-41

Two Young Females of *Kogia breviceps*

PLATE 36

A. Head of female, Western Australia; B, female on beach, South Australia.

PLATE 37

Dorsal views of skulls of (A) Western Australian and (B) South Australian females (to same scale).

PLATE 38

Skulls of (A) Western Australian and (B) South Australian females, as seen from the side (to same scale).

PLATE 39

Rear views of skulls of (A) Western Australian and (B) South Australian females (to same scale).

PLATE 40

A. Tongue bones and (B) sternum of South Australian female (not to same scale).

PLATE 41

Vertebrae. Western Australian female; A and B, cranial and side views of cervicals; C and D, anterior and side views of last (thirteenth) thoracic. South Australian female; E and F, cranial and side views of cervicals; G and H, anterior and side views of last (thirteenth) thoracic. (All to same scale.)

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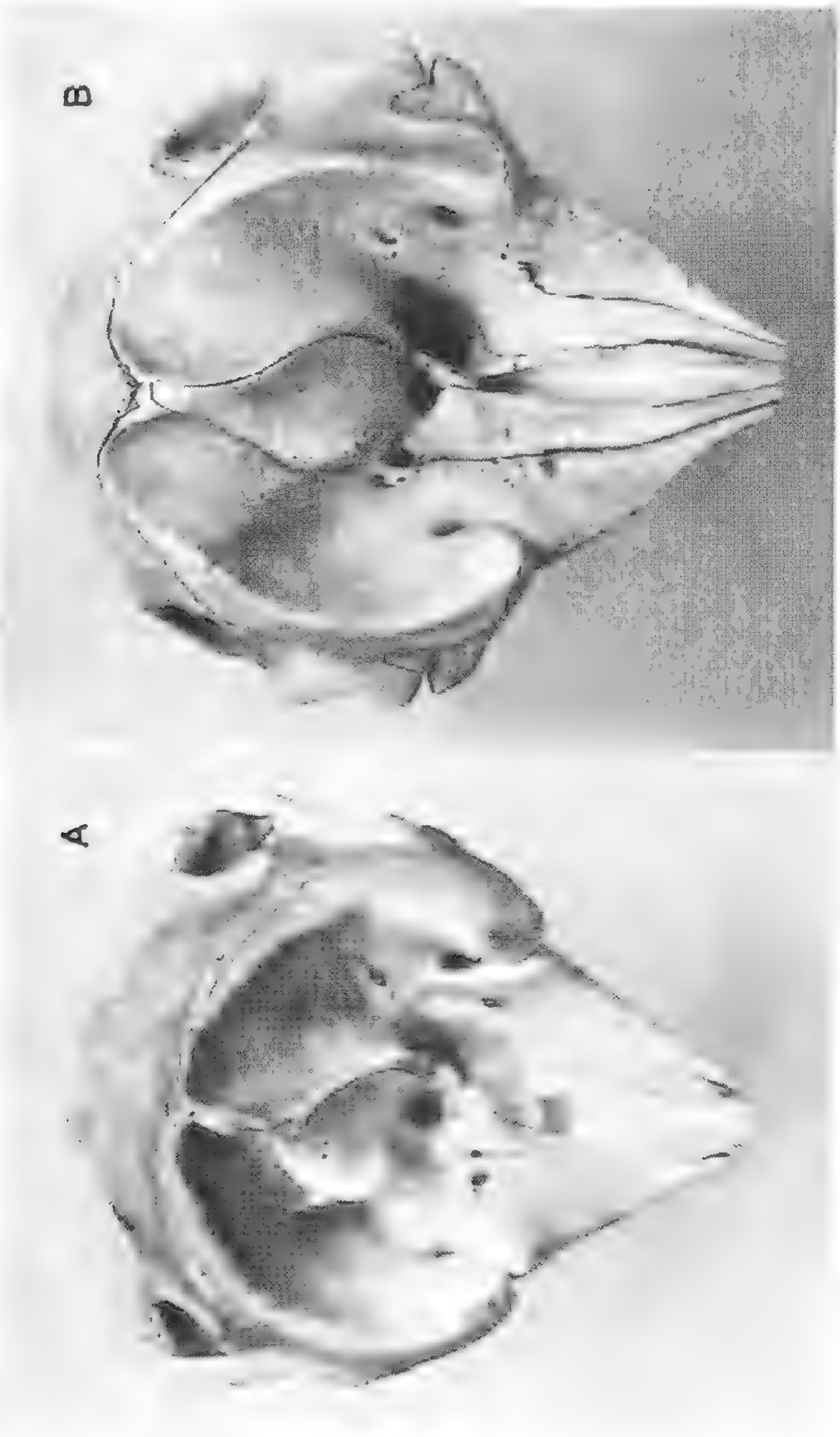
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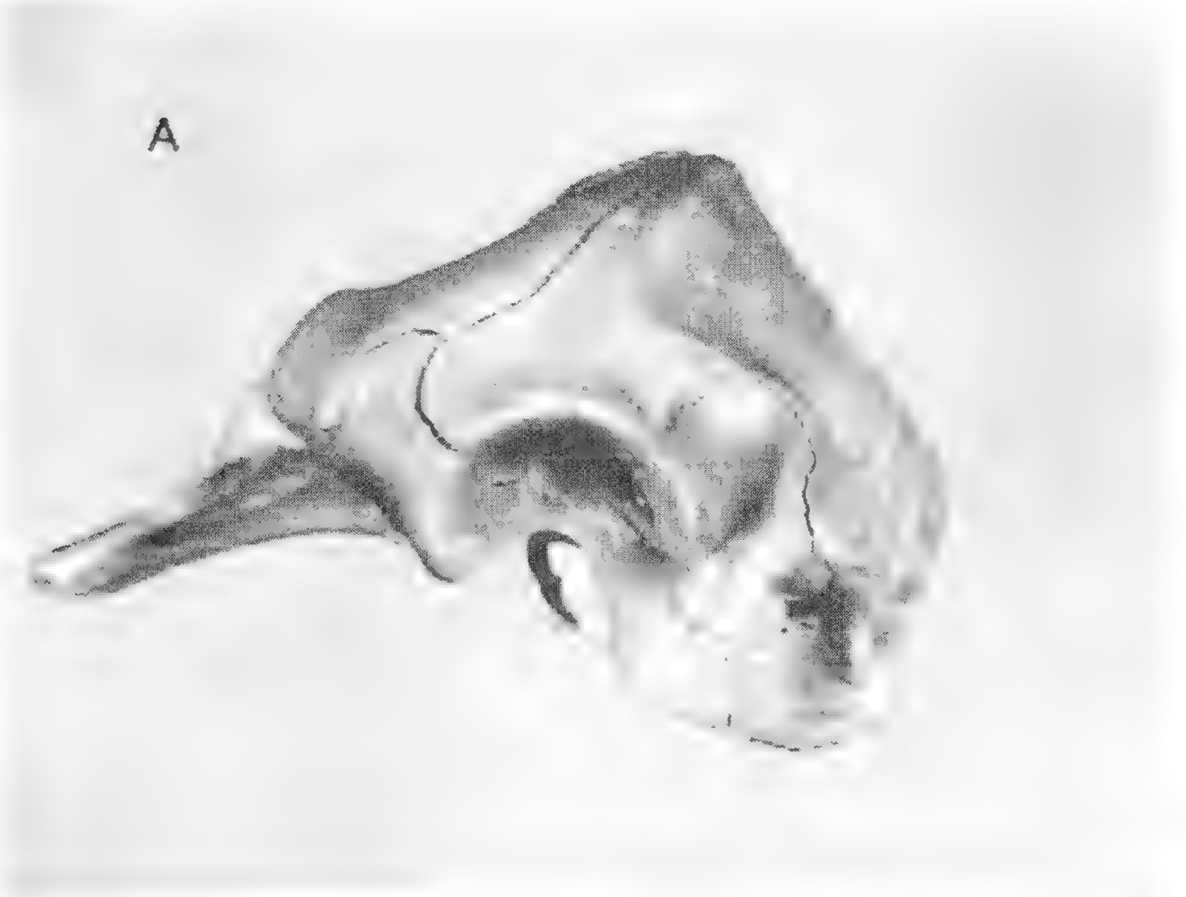

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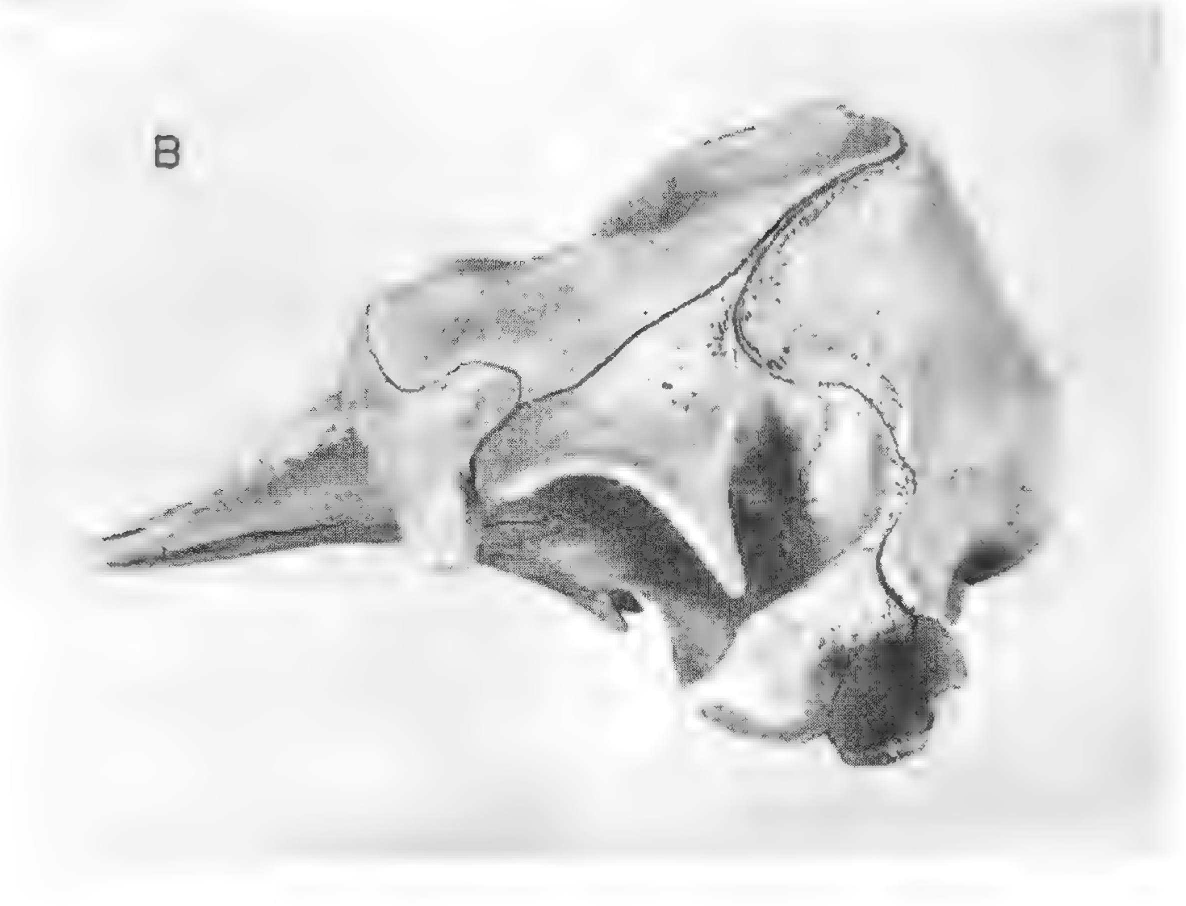

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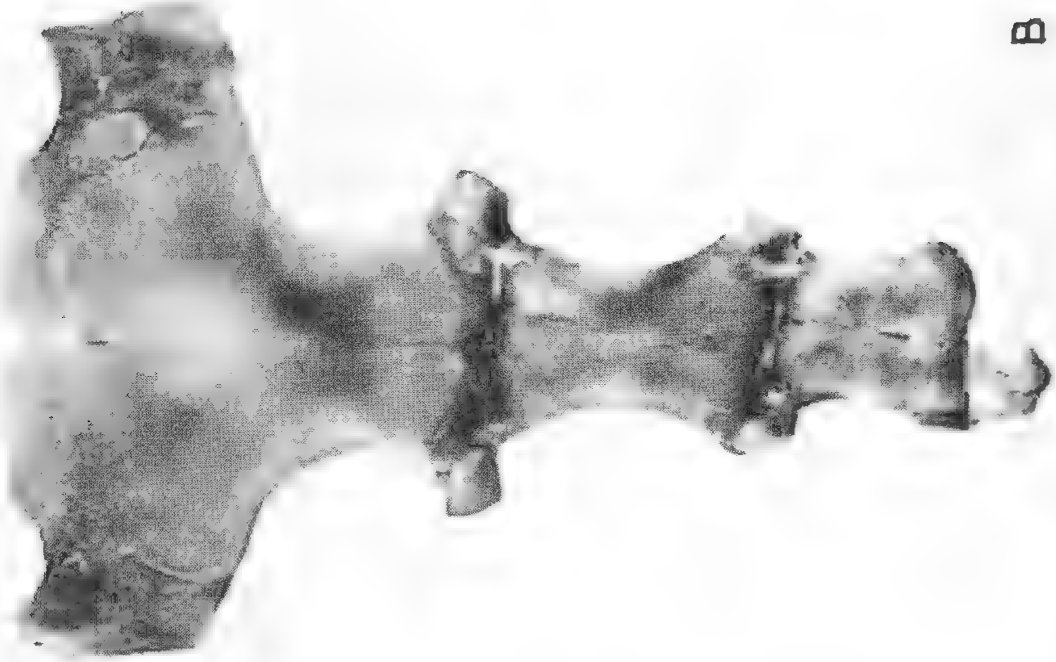

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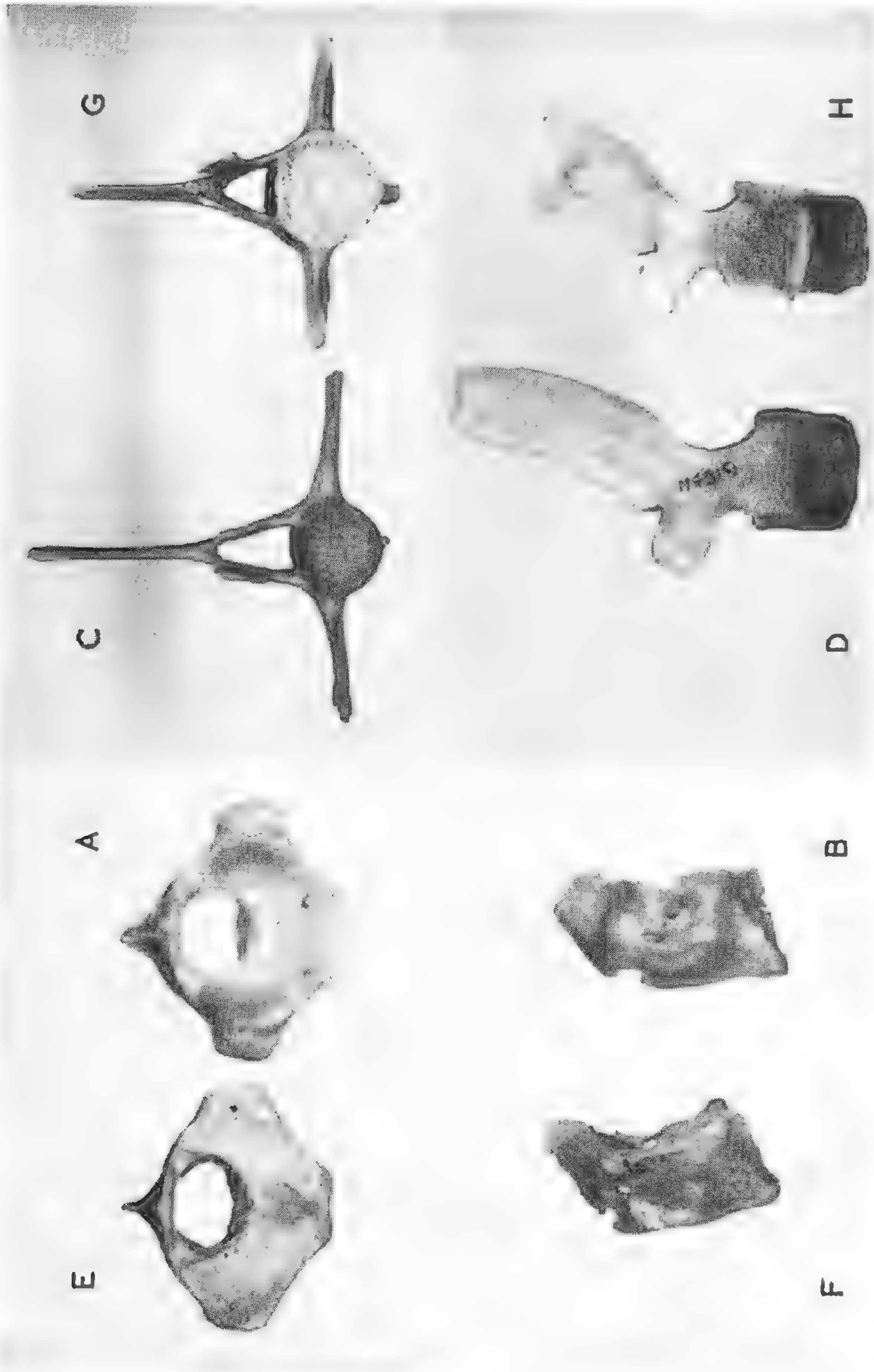
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THE FOSSILIFEROUS CAMBRIAN SUCCESSION ON FLEURIEU PENINSULA, SOUTH AUSTRALIA

BY BRIAN DAILY, UNIVERSITY OF ADELAIDE

Summary

Adelaide Supergroup and Marino Group are proposed to replace the terms Adelaide System and Marinoan Series.
Arising from the discovery of Lower Cambrian fossils in metamorphosed rocks at Delamere a conformable sequence from the Precambrian Tapley Hill Slate to the Cambrian Carrickalinga Head formation has been established for the Delamere region.
Comparison of this Precambrian-Cambrian sequence with that found north of Normanville indicates that only minor facies differences exist between the two regions.
The Cambrian-Precambrian boundary is placed below the oldest fauna near the top of the Mount Terrible Formation, which is stratigraphically above the Marino Group.

THE FOSSILIFEROUS CAMBRIAN SUCCESSION ON FLEURIEU PENINSULA, SOUTH AUSTRALIA

By BRIAN DAILY, University of Adelaide

Plate 42 and text fig. 1

SUMMARY

Adelaide Supergroup and Marino Group are proposed to replace the terms Adelaide System and Marinoan Series.

Arising from the discovery of Lower Cambrian fossils in metamorphosed rocks at Delamere a conformable sequence from the Precambrian Tapley Hill Slate to the Cambrian Carrickalinga Head formation has been established for the Delamere region.

Comparison of this Precambrian-Cambrian sequence with that found north of Normanville indicates that only minor facies differences exist between the two regions. The Cambrian-Precambrian boundary is placed below the oldest fauna near the top of the Mount Terrible Formation, which is stratigraphically above the Marino Group.

The marble on Mount Rapid is equated with the Brighton Limestone and the Rapid Bay marble is tentatively regarded as being the same formation.

INTRODUCTION

The stratigraphy, structure and age relationships of the pre-Permian sedimentary sequences developed on Fleurieu Peninsula have given rise to much speculation among geologists.

Historically, Fleurieu Peninsula is important in that the discovery by Sir Edgeworth David of a Cambrian fauna in the Normanville district and the extension of this fauna to the Sellick Hill district by Howchin (1897) has provided the only means of dating the folded sediments comprising the Mount Lofty Ranges. Until recently, all subsequent fossil discoveries had been confined to this narrow belt of unmetamorphosed Cambrian rocks outcropping from a point three miles south-west of Willunga to just north of Normanville.

To the south of Normanville an extensive belt of Permian glacial deposits effectively conceals any southward continuation of the fossiliferous Cambrian and older rocks. Further south in the Rapid Bay-Second Valley area there are marbles which strike across the Bay towards the fossiliferous Cambrian in the north. After mapping the lowgrade metamorphics occurring on the coastline between Sellick Hill and Victor Harbour, Madigan (1925) concluded that the marble occurring on Rapid Head could be correlated with part of the proven Cambrian sequence and that "the structure is simple and the field relations are all in favour of the Cambrian age of the Fleurieu Peninsula."

Sprigg and Campana (1953) were able to show that the structure is not simple but reported that *as anticipated* Adelaide System rocks (including Sturt Tillite) formed a closure around the south end of the Yankalilla Archaean inlier and that the Rapid Bay Marble and overlying calcareous phyllites which they correlated with the Archaeocyatha limestones and overlying phosphatic shales of the Sellick Hill area, "also nosed irregularly around the structure". In addition, they indicated that sediments typical of the Kanmantoo Group succeeded the phyllites and occurred "on both the east and west limbs of the locally overturned regional fold." A Cambrian to Ordovician age was suggested for the Kanmantoo Group. Later, these observations were supported or reaffirmed by Campana, Wilson and Whittle (1954a, 1955), Campana (1955), Campana and Wilson (1955). This correlation of the Rapid Bay Marble with the Cambrian limestone has been generally accepted by most South Australian geologists.

In 1962, at the suggestion of Mr. J. L. Talbot, Geology Department, University of Adelaide, five post-graduate students within the Geology School were assigned geological mapping projects between the Yankalilla Archaean inlier and the Rapid Bay-Delamere region. A reason for choosing this region was that it appeared to be structurally interesting. When consulted about the possible age relationships of these metamorphosed rocks the author decided to demonstrate the well known Cambrian sections at Sellick Hill and Carrickalinga Head so that the knowledge gained could be applied to the south. Subsequently, a traverse was made along Stockyard Creek, Delamere, the intention being to *predict* our way through the section. The metamorphosed equivalents of ten Cambrian rock units occurring between Sellick Hill and Carrickalinga Head were all recognized and located in their correct stratigraphic positions thus establishing lithological correlation between the two regions. Subsequently, when demonstrating the same section to third year geology students Cambrian fossils were found in two of the three units where fossils might reasonably be expected to occur in these metamorphosed rocks.

The fossil discoveries appeared to confirm Madigan's contention that the Delamere-Rapid Bay marbles were in fact Cambrian in age. They also indicated that the core of the overturned anticline between Starfish Hill and Delamere as mapped by Campana and Wilson did include rocks of Precambrian age, thus confirming the suggestion made by these workers on their map legend and in the accompanying explanatory notes. However, subsequent investigations carried out by the author have indicated that this anticline, as shown on the Jervis sheet, does not exist and that there is apparently a complete sequence from laminated phyllites, herein equated with the Tapley Hill Slate, up to and including the Kanmantoo Group. In addition, evidence, although inconclusive at present, indicates that the Rapid Bay Marble itself may not be Cambrian in age but may approximate to the Brighton Limestone of the Adelaide region.

I. THE CAMBRIAN NORTH OF NORMANVILLE

Abele and McGowran (1959) have given an excellent account of the Cambrian geology of the Normanville-Sellick Hill region. They divided the sequence into five formations, four of which they formally named. For mapping purposes, the base of the Cambrian was drawn at the base of the thin *Hyolithes* sandstone member of the Wangkonda Formation. Horwitz, who mapped the continuation of the Sellick Hill Cambrian to the north-east on the Milang sheet (Horwitz and Thomson, 1960), extended the Cambrian boundary down to the base of an arkose more than 200 feet stratigraphically below that determined by Abele and McGowran.

Stratigraphy

In fig. 1 the stratigraphic columns for the Sellick Hill and Carrickalinga Head areas and the accompanying explanations briefly summarize the author's present knowledge and opinions of the geology of the region. A terminology somewhat different from that used by Abele and McGowran has been erected and reasons for this are given in following paragraphs.

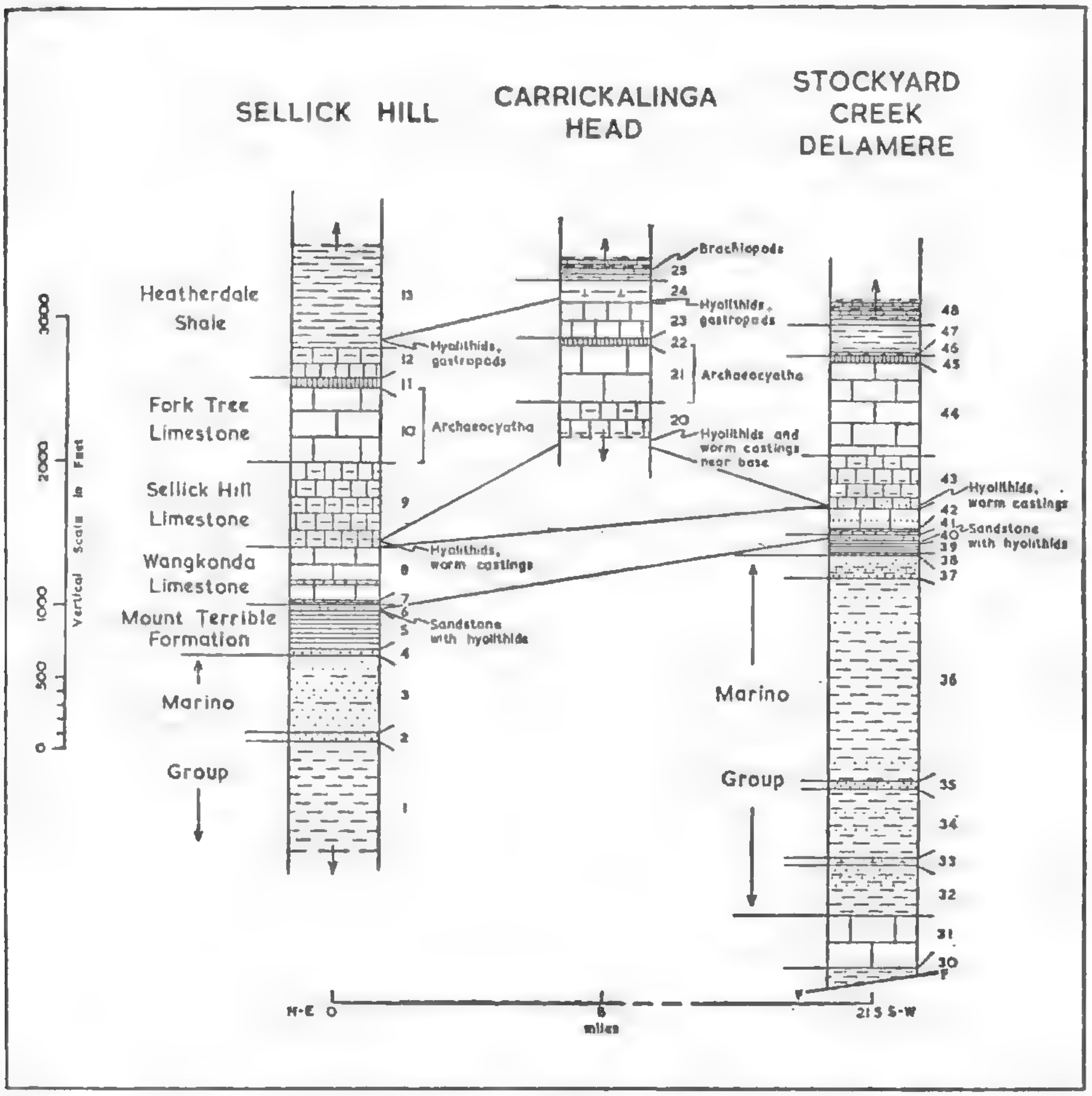

FIG. 1. CORRELATION OF CAMBRIAN SECTIONS, FLEURIEU PENINSULA.

Sellick Hill area.

1. Olive-coloured siltstones passing to chocolate shales below.
2. Massive quartzite, flaggy sandstones and siltstones.
3. Thin siltstones interbedded with flaggy quartzite, and thin massive light blue quartzites.
4. Arkosic sandstones, siltstones.
5. Dark grey siltstones with increasing carbonate content towards top.
6. Sandstones, with carbonate rich pods, hyolithids, gastropods, sponges and other organisms.
7. Flaggy argillaceous limestone.
8. Massive pale blue grey limestone, massive mottled limestone and thin sandstones.
9. Mottled and banded argillaceous limestones and calc-shales, coarse sandstone lenses near base. Hyolithids, gastropods, brachiopods and other organisms.

10. Massive non-argillaceous limestones with Archaeocyatha, brachiopods and abundant phosphatic shelled organisms.
11. Mottled argillaceous limestone with hyolithids, sponges and brachiopods.
12. Flaggy argillaceous limestones and dark coloured calc-shales with carbonate and phosphate nodules. Hyolithids, *Helcionella*.
13. Black shales with phosphate nodules. *Scenella*.

Carrickalinga Head area.

20. Sandstones with worm castings and burrows, calc-shales, mottled and banded limestones with hyolithids and other organisms.
21. Massive, generally dolomitised, clean limestone with Archaeocyatha.
22. Massive and mottled argillaceous limestone.
23. Rubbly banded argillaceous limestones with interbedded calc-shales.
24. Calc-shales with carbonate and phosphate nodules. *Helcionella*, hyolithids, sponges.
25. Thin alternating bands of shale and graywacke. (*Lingulella* in shale near base.)

Stockyard Creek area.

30. Finely laminated black calc-phyllites.
31. Dark blue argillaceous limestones; cream, buff and light blue-grey banded marble.
32. Dark coloured siltstones with quartzites, especially near top.
33. Cross-bedded coarse to pebbly calcareous sandstone, quartzite, marble ("gritty marble").
34. Laminated siltstones, cross-bedded quartzites, siltstones.
35. Massive quartzite.
36. Green to grey siltstones, phyllites with siltstones and graywacke.
37. Thin flaggy and rippled clean quartzites and siltstones with thin bands of massive quartzite.
38. Massive arkose.
39. Grey phyllites with thin calc-sandstones.
40. Calc-sandstone with hyolithids and gastropods; grits; arkose; unit is very calcareous near top.
41. Mottled argillaceous limestone.
42. Banded marbles with sandstone (similar to item 40) and conglomeratic sandstone.
43. Mottled and banded argillaceous limestones, marbles, calc-phyllites. Lenses of sandstone with worm castings and hyolithids near base.
44. Massive banded marbles.
45. Massive and mottled argillaceous limestone.
46. Dark phyllite with argillaceous limestone nodules.
47. Dark phyllite with phosphate nodules.
48. Alternating bands of phyllite and graywacke.

Marino Group (Adelaide Supergroup)

W. Howchin in many publications prior to 1922 referred to all of the rocks of the Adelaide region above the 'Archaean' complex and below the Permian as the *Cambrian Series*.

David (1922) tentatively suggested "that all the strata from the base of the Archaeocyathinae limestones to the basal conglomerates overlying the Archaean(?) schistose rocks of Aldgate in the Adelaide region, be given some local name such as 'the Adelaide series', and, for the present I would suggest that they may be classed, provisionally, as Proterozoic(?). It is quite possible that more than one series of rocks are included in the suggested Adelaide series."

I believe that David's intention in using Adelaide Series was to overcome the need to call these beds Cambrian. In this way he discarded the unwanted time sense of Howchin's terminology and used Adelaide Series in the sense that we would now use Group or Supergroup. Without any accompanying explanation, Howchin (1923) restricted the term Adelaide Series to the Brighton Limestone and underlying strata. In all subsequent publications he used the term in this restricted sense, but his opinions regarding its age varied from Upper Precambrian to Lower Cambrian. David (1927) after reviewing world occurrences of the Archaeocyatha concluded that "the Lower Cambrian age of the greater part, if not the whole of the Adelaide Series (in David's original sense; B.D.) is rendered very probable". However, David (1932) finally accepted Howchin's subdivisions but regarded the Adelaide Series as Newer Proterozoic.

Subsequent to Mawson (1940), the use of the term Adelaide Series has largely depended on the definition of the base of the Cambrian. In the Flinders Range, Mawson broke with the Howchin tradition by including all strata below the Pound Sandstone in the Adelaide Series. Sprigg (1942) working in the type area included the "Pre-Archaeocyathinae Grey Quartzites" in the Adelaide Series. These he regarded as "the equivalent of Mawson's Pound Quartzite".

Mawson supports the contention that David used the term Adelaide Series in a rock-stratigraphic sense. Mawson (1939) stated, "Thus it was then suggested to Howchin by the late Sir Edgeworth David and the writer that a local name should be applied, non-committal as to age, and with the understanding that as knowledge of the formations progressed it should be dropped in favour of divisional names. Thus the term 'Adelaide Series' was created as a temporary working tool".

The term Adelaide System was first used by Clarke (1938) and not by Mawson (1948) as generally believed. System was used to replace Series *in Howchin's restricted sense.* His choice of the term System was influenced partly by the subdivision of the Adelaide Series into the Para and Narcoota Series by Hossfeld (1935), and by Mawson's work in the Wooltana district (Mawson, 1934) which was subsequently modified (Mawson, 1948). Wilson (1952) regarded

Hossfeld's Para Series as the equivalent of the more recently defined Torrensian Series but the mapping of the Gawler Sheet (Campana, 1953) indicated that the Narcoota Series embraced rocks belonging to the Para Series and ranging as high as the Kanmantoo Group. It is regrettable that Mawson and Sprigg (1950) did not consider Hossfeld's terminology when discussing the subdivision of their Adelaide System. It is quite clear that the Para Series as defined by Hossfeld (1935, p. 34 and geological map) is not only synonymous with the Torrensian Series but that it also embraces the same type area originally mapped by Howchin.

David (1950), and later Mawson and Sprigg (1950) formally defined the term Adelaide System. David, following Howchin, restricted the System to the Brighton Limestone and underlying beds. He divided the sequence into Lower and Upper Series, with accompanying Stage names, some of which were used by Sprigg (1946). Mawson and Sprigg rejected this subdivision and erected an independent terminology for a System extending from the Aldgate Sandstone to the top of Sprigg's "Pre-Archaeocyathinae Grey Quartzites". They subdivided the System as found in the Adelaide Region—the type area—into three Series, the Torrensian, Sturtian and Marinoan. This subdivision has been accepted and used extensively by South Australian geologists. Quite erroneously, another and presumed older series, the Willouran Series (type area about 350 miles north of Adelaide), has since been included in the System.

System and *Series* are time-stratigraphic terms based on a column of rocks to which geological time significance is attached. The System (Series) in its type area is based on a sequence of rocks but recognition of the System (Series) elsewhere must be based on some reliable means of correlation, normally fossils. The general lack of fossils in Precambrian rocks implies that correlation can be rarely attained for these rocks.

The term, Adelaide System (Marinoan Series), in the type area has been accepted but its application elsewhere immediately implies a correlation which generally cannot be substantiated. It is proposed that we abandon the use of the term Adelaide System and the accompanying Series terms and substitute for them the more acceptable rock-stratigraphic terms, *Supergroup* and *Group*. These terms then could be legitimately used beyond the type area since they do not imply correlation. Such a move would be in keeping with the recommendations contained in the American Code of Stratigraphic Nomenclature (1961) and in the proposed revision of the Australian Code of Stratigraphic Nomenclature.[1]

Mawson and Sprigg inferred that their Marinoan Series ended at the beginning of the Cambrian. In redefining these rocks as a group it is necessary to define the upper limit. This I have taken as the sequence of thin light coloured massive quartzites interbedded with rippled siltstone and flaggy quartzites that form bold outcrops along the front of the Willunga Scarp. Lower in the sequence, green to olive coloured siltstones pass gradually into chocolate slates with mud-cracks and ripples. The sequence is interpreted as a shallow-water deposit which, during the time of deposition of the red beds, experienced short periods of emergence. On the Milang sheet, Horwitz (in Horwitz and Thomson, 1960) mapped laminated purple and green shales at the top of the Marino Group, but the unit is not present at Sellick Hill, where Thomson and Horwitz (1961) have proposed an unconformity between the Marino Group and an overlying arkose "marking the onset of a new sedimentary cycle". This contact cited as evidence for unconformity is a cut and fill contact with the cut made in unconsolidated sediment. The contact cannot be accepted as evidence of unconformity. Further south, near Carrickalinga Hill, in a tectonically complicated area, evidence cited for an unconformity is best interpreted as due to faulting.

Mount Terrible Formation

This new name is proposed for a sequence of dominantly clastic rocks above the Marino Group and below the Wangkonda Limestone. The name is taken from the rise called Mount Terrible, 4 miles southwest of Willunga.

Three members can be distinguished and together these constitute an easily recognizable unit. The formation is well exposed on the new Sellick Hill-Myponga road and in the deep creek immediately south of the road. The basal part of the lowest member, about 40 feet thick, is a cross-bedded coarse-grained arkose with thin silty partings. The upper part of the member is quite silty but contains thin beds of coarse sandstone some of which have been leached of their carbonate content. This part of the member is lithologically similar to the uppermost member (*Hyolithes* sandstone) and weathers

(1) During a discussion at a meeting of the Geological Society, South Australian Division, Dr. A. W. Kleeman independently proposed the use of the term *Group* instead of *Series*.

giving a characteristic intermittently cavernous appearance parallel to the bedding. The bedding is quite irregular and gives every indication of being reworked by organisms. Worm castings are common on bedding planes but no other fossils have been found in the member.

The middle member is a sequence of dark grey siltstones (weathering yellow) about 200 feet thick which towards the top become more noticeably cavernous in weathered outcrop. In places, disruption of the bedding by worms leads to a characteristic spotted appearance of the rock. (Kraaksten type bedding of European authors; Dr. A. A. Opik, personal communication.)

The upper member, the *Hyolithes* sandstone of Abele and McGowran (1959) consists of 45 feet of sandstones and coarse siltstones. The most conspicuous feature of the unit is its strongly cavernous nature (plate 42, C). The cavities are elongated parallel to the bedding and many contain pockets of residual clay. The hyolithids occur in a band of clay in weathered sandstone twenty feet below the top of the member. The fauna is rich and includes sponges, two genera of gastropods and many unidentified organisms. It is the oldest Cambrian fauna located in the region. Intensive re-working of parts of the unit by worms has given rise to a kraaksten rock.

The cavernous nature of the weathered outcrop of all members has resulted from the leaching of carbonate rich patches and nodules, observed only in fresh outcrops, as in the deep creek below the new Sellick Hill-Myponga road.

As pointed out by Horwitz (1960) and Thomson and Horwitz (1961) the arkose marks the beginning of a new sedimentary cycle. It separates the essentially non-carbonate red beds of the Marino Group from the dominantly carbonate rich rocks of the Lower Cambrian. Its significance is discussed in later paragraphs.

Wangkonda Limestone

The Wangkonda Formation was erected by Abele and McGowran (1959) for the *Hyolithes* sandstone and the limestones below the flaggy Sellick Hill Limestone. In this paper the *Hyolithes* sandstone is included within the Mount Terrible Formation and the term Wangkonda Limestone is applied to the limestone member. The lowest unit is a flaggy and mottled argillaceous limestone which contains an assemblage of fossils similar to that found near the top of the underlying formation. The limestones above are massive and generally clean, but mottled argillaceous limestones are also present. A prominent calcareous sandstone with some kraaksten structure is also included. The Archaeocyatha recorded by Campana, Wilson and Whittle (1955) have been examined and found to be oolites. Oolitic and fragmental limestones occur commonly within this formation.

Sellick Hill Limestone

The contact between the Wangkonda Limestone and Sellick Hill Limestone on the new road is a cut and fill contact (plate 42, A). At the contact hyolithids, gastropods and other organic remains are found in the basal coarse sandy facies of the Sellick Hill Limestone. Faunas occur throughout the formation but are sparse in comparison with those found in the lower 30 or 40 feet, where worm castings and burrows are prominent in quartz sandstone. Strong current action is not only indicated by the nature of the contact (which in some ways suggests it has been cut in lithified rock)[2] but also by the current-sorted and serially inserted hyolithids. The sandy facies is a persistent feature over a large area but is not developed in some sections. It is quite an important feature from Myponga Beach to over a mile to the south-west along the coastline where carbonate cemented sandstones are well developed. Although the base of the formation is there below sea level, about 100ft. of coarse angular sandy sediments with hyolithids and abundant worm castings (some over two inches wide) are exposed.

Higher in the section are several continuous bands of intraformational conglomerates, generally less than a foot thick. These conglomerates are composed of the limestone pebbles that remained after the interbedded muds were winnowed out by strong current action. Abundant fossils, also concentrated, sorted and oriented by this current action, are frequently associated with these conglomerates.

The lithological variation of the Sellick Hill Limestone has been described by Abele and McGowran (1959). The lower part is essentially a calcareous shale, but above, banded and nodular argillaceous limestones alternating with calc-shales are characteristic,

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(2) Dr. A. A. Opik (personal communication) has suggested that this contact is due to submarine solutional effects. This idea is supported by the fact that the upper surface of the Wangkonda Limestone is differentially phosphatized (residual phosphate on a corrosion surface).

making the recognition of these mottled beds comparatively easy. The Sellick Hill Limestone is similar to the Parara Limestone of Yorke Peninsula, but unlike that formation contains *no* trilobites.

Fork Tree Limestone

This formation is divided into two members, the thicker and lower one being a massive partially recrystallized clean limestone containing Archaeocyatha, phosphatic shelled organisms and sponge remains. The limestone is variously dolomitised. The upper member, a massive strikingly mottled limestone, is only sparsely fossiliferous.

Heatherdale Shale

This formation was divided by Abele and McGowran into a lower calcareous member and an upper member which is a black shale almost free of carbonate. The boundary between the two members is really a subjective issue. The lower part of the formation is extremely variable lithologically and the thickness of the carbonate developments vary as do also the type of limestone. In the Sellick Hill region thin weathered shale with phosphate nodules separates flaggy limestones from the underlying mottled member of the Fork Tree Limestone. Above this there is a gradual transition through shales with interbedded lenticles and nodules of limestone to essentially non-calcareous phosphate rich shales. At Carrickalinga Head above the Fork Tree Limestone is a thick sequence of rubbly argillaceous limestone which gives way to calc-shales containing large carbonate nodules. Phosphate nodules occur in both the rubbly limestone and calc-shales. The upper member, as recognized in the Sellick Hill region, cannot be recognized in this section. Hyolithids, sponges, brachiopods and gastropods, which include *Helcionella,* occur sporadically throughout the formation.

Carrickalinga Head formation

This term is here used informally for a sequence of *alternating* thin olive-coloured shales and thin graywackes that occur in the Carrickalinga Head region. The base of the formation is marked by the first band of olive-coloured shale that appears above the carbonate rich member of the Heatherdale Shale. Abele and McGowran (1959) have erroneously included this band as the upper member of the Heatherdale Shale. *Lingulella* is the only fossil found in the formation, within 30 feet of the base. The contact with the underlying

Heatherdale Shale is sharp and the formation represents the beginning of a new cycle of deposition. The top of the formation is concealed below the sea.

II. THE CAMBRIAN OF THE RAPID BAY-DELAMERE REGION

Geological investigations were concentrated in the strip of country bounded by the Stockyard Creek and the main road linking Delamere and Rapid Bay. The observations were also supplemented by work carried out between this area and Myponga reservoir.

Stockyard Creek Section

Stratigraphic observations were initiated in Stockyard Creek. Here, Mr. W. C. Leslie, University of Adelaide, who is currently mapping the area, assured me there were good exposures. As a knowledge of this section is vital for the understanding of the geology of the region a considerable amount of detailed work was carried out along this creek. The results are summarized in fig. 1.

Thicknesses given for this column have been computed from the aerial photographs except for those mentioned in the text which have been measured.

On the Jervis sheet, along Stockyard Creek, Campana and Wilson have delineated an overturned anticline with Cambrian rocks on both limbs. Examination of this section reveals that the stratigraphy on the two limbs of the alleged anticline is so vastly different that even neglecting facings (these are not readily available), it is not possible to interpret the sequence as an anticline. The phosphatic phyllites, which Campana and Wilson used to delineate the structure not only for this part of the alleged anticline but also to the north in the Rapid Bay region (see especially Campana, 1955, fig. 1) could not be located on the overturned limb. Phyllitic rocks do occur there but they are not phosphatic. Later search revealed that all the beds on the "overturned" limb were right way up according to the many facings obtained on cross-bedded rocks. Further, it was found that the phyllites are faulted against south-east dipping arkosic beds mapped as overturned Kanmantoo Group rocks. These also face east and so are not overturned. The stratigraphic position of these "Kanmantoo Group" rocks has not yet been established. The details of this section along Stockyard Creek are shown below.

Sturt Group

The oldest rocks found along the line of section are laminated black phyllites with well developed lineations and boudinage structure. These rocks are faulted against south-east facing arkosic rocks which strike into them. The actual contact occupies the bed of the creek and is not observable. These black phyllites can be correlated with the Tapley Hill Slate. Thicker developments of these phyllites occur to the north-east where they are particularly well exposed in No Where Else Creek. The phyllites are calcareous and pass gradually into a thick flaggy limestone-marble sequence which approximates to the Brighton Limestone of the Adelaide region. The boundary as in the Adelaide region is a gradational one and I have made no attempt to define a position for it. The limestones vary from dark blue grey argillaceous limestones and calc-shales to very pure banded cream, buff and light blue grey marbles. The upper part contains evidence which indicates that the beds were of shallow water origin. They are rippled and contain mud cracks and mud pellets. The beds are quite lenticular.

Marino Group

Difficulty was found in establishing a boundary between the Sturt and Marino Groups and the lowest unit included in the Marino Group might well be included with the Brighton Limestone. This lowest unit is a well laminated dark blue-grey to black calcareous siltstone. It is succeeded by dark-coloured current bedded siltstones and silty quartzites with thin interbeds of cleaner quartzites. Mud cracks were found not only in this but also in a quartzite-siltstone sequence which lies stratigraphically above. Higher in the section there is a coarse to pebbly calcareous sandstone with clean and sandy marble lenses. This important unit is quite useful for mapping purposes and is hereafter referred to as the "gritty marble". Above is a thick sequence of laminated siltstone with minor quartzite interbeds. The lower part of the unit is banded in such a way that it recalls the type of banding in the Marino Group siltstones of the wave cut platform north of Black Point, Hallett Cove. About 50 feet of massive dark grey pebbly quartzite underlies about 1,400 feet of soft and poorly outcropping siltstones and phyllites which become coarser in their upper part. Thin greywackes are included in the upper part of this unit. The phyllites are strongly lineated and some are rich in magnetite. The uppermost unit of the Marino Group consists of a sequence of alternating flaggy and ripple marked quartzites, laminated siltstones and at least three massive clean quartzite bands which form prominent outcrops throughout the district. This unit is equated with the uppermost unit of the Marino Group found in the Sellick Hill district.

Mount Terrible Formation

A massive arkose band five feet thick is overlain by a thin sequence (about 60 feet) of light grey phyllites which include at least two thin bands of calcareous sandstone. The beds, particularly the sandstones, weather with a characteristic cavernous appearance identical to that found in the same formation at Sellick Hill. The bedding is quite irregular in the sandstones and worm activity is evident on their bedding planes. The uppermost unit included in the formation is a sandstone, 40 feet thick, which forms a hard band across the bed of the creek. It varies from a fine to coarse grained sandstone and contains pebble lenses and coarse arkose. The rock is patchily calcareous throughout, the uppermost 6 feet (poorly exposed) being a sandy marble. Twelve feet above the base is a three to four inch calc-sand band containing abundant hyolithids and scanty gastropod remains. Away from the creek the sandstone assumes a strong cavernous character on weathering (plate 42, D).

Wangkonda Limestone (Marble Phase)

A blue-grey argillaceous limestone outcrops in the bed of Stockyard Creek. It is correlated with the lowest member of the formation at Sellick Hill and is overlain by massive light blue-grey to pink marbles which are split by a band of sandstone, twelve feet thick, similar to that which contains the hyolithids in the Mount Terrible Formation. The uppermost part of the sandstone is a fine grained conglomerate with well rounded quartz grains. Some fine crystalline dolomite bands occur within the formation.

Sellick Hill Limestone

The boundary between the Wangkonda Limestone and Sellick Hill Limestone is visible in a road cutting on the south side of the creek and also in a small quarry 100 yards to the south (plate 42, B). The basal portion of the unit in the quarry consists of a thin white gritty sandstone eight inches thick which lenses out within the length of the quarry. It contains worm castings and numerous serially inserted hyolithids. About five feet of the weathered formation, mainly leached calcareous shale, calc-siltstones and lenticular limestones, are exposed above the marble. One calc-shale band up to three inches thick contains numerous hyolithids. In the road cutting, the Wangkonda Limestone is overlain by leached grey to yellow calc-shales. Thin sandy interbeds contain evidence of worm activity. The weathering pattern is strikingly similar to that seen in the same formation on the old Sellick Hill-Myponga road. Hyolithids occur within three feet of the contact.

The remainder of the formation is mainly seen in small quarries and in a large road cutting on the Cape Jervis-Yankalilla road. The lower part is a laminated calcareous shale becoming more calcareous above and developing into banded and nodular mottled limestone. The only apparent difference between this formation here and the Sellick Hill region is that there is a decided drawing out with consequent flattening of the limestone nodules and bands. This is a tectonic affect. As well some of the purer limestone bands have been altered to marbles, the shales to phyllites.

Fork Tree Limestone (Marble Phase)

Both members of the formation are located on the east side of the Cape Jervis road. The thick lower member is represented by very pure, banded and coarse-textured, light-coloured marbles. The upper unit, a dark coloured and mottled argillaceous but massive limestone, is well exposed in a quarry on the north side of the creek.

Heatherdale Shale (Phyllite Phase)

Above the mottled limestone is a blue-black weathered phyllite containing flattened calcareous nodules which weather out and cover the ground. This corresponds to the lower member of the formation as recognized in the Sellick Hill region. The upper member is a dark phyllite which contains abundant carbonaceous and phosphatic nodules. The best outcrops are found high on the slopes above the creek.

Carrickalinga Head formation

This formation is easily recognized and consists of alternating thin bands of soft brown phyllite and massive dark graywackes of similar order of thickness to the beds found on Carrickalinga Head. The contact with the underlying Heatherdale Shale was not observed. This formation is accepted in this paper as the lowermost unit of the Kanmantoo Group.

III. DISCUSSION

Regional metamorphism has affected the rocks, particularly the finest clastics and the purer limestones, but the grade is low and no difficulty is experienced in establishing lithological correlations with the Cambrian-Precambrian sequence to the north of Normanville.

Pure limestones were the most noticeably affected, going to banded, generally coarse-textured marbles, the banding being a metamorphic effect. It parallels the axial plane of the folds which in turn approximates to the true bedding as seen in other rock types. Massive mottled limestones with little original argillaceous components have been recrystallized to produce marbles, with thin schistose bands.

Flaggy, mottled and banded argillaceous limestones such as the Sellick Hill Limestone were apparently little affected structurally, but their textures were variously changed, depending on original composition. Calcareous shales have been altered to phyllites, the more argillaceous limestone bands and nodules being flattened and drawn out parallel to the fold axis with little increase in grain size. (Very strong lineations, plunge 30°, direction 140°, remarkably constant, are recorded throughout the Rapid Bay—Delamere area.) The purer limestones have altered to marble.

The fossils found near Delamere in the sandstones have not been greatly affected by the regional movements, the most conspicuous effect being flattening with distortion in the axial plane.

One of the most obvious things that emerges from the consideration of the stratigraphy of the region, for that portion of the geologic column studied, is the remarkable constancy of facies. Certainly, *minor* facies differences do occur but these do not detract from the overall picture.

The only facies changes of any particular note are related to the lower portion of the Heatherdale Shale, where both laterally and vertically there is variation in the shale-carbonate ratio. A practical expression of this variation are the various types of mottled, nodular and flaggy limestones that are encountered in the various sections. There is also some variation in the lower part of the Sellick Hill Limestone where coarse sandy lenses are frequent. In some sections the sands are entirely missing, whereas in others such as in a quarry immediately east of Fork Tree Homestead, the lower part of the formation is a thick sandstone with leached calc-shale interbeds.

A glance at fig. 1 indicates that the Mount Terrible Formation rests on Marino Group quartzites and siltstones in both Stockyard Creek and at Sellick Hill and that this unit is underlain by siltstones which pass down into thick sequences of finer grained rocks. These two units are equated in both sections.[3] Examination of the uppermost unit of the Marino Group indicates that the sediments are lenticular and are of shallow water origin; periods of temporary exposure are indicated by mud cracks. A paralic environment is suggested for the deposition of the unit. Rocks similar to those of the Marino Group were deposited during the Lower and Middle Cambrian elsewhere in the State and a comparable environment of deposition for them has been invoked by Daily (1956). It is worth noting here that these proven Cambrian rocks are devoid of all animal life except trilobite tracks and burrows and therefore represent an environment apparently unsuitable for the preservation of skeletal material. One must keep these facts in mind when final consideration is being given to the determination of the Cambrian-Precambrian boundary.

The Mount Terrible Formation introduces a new cycle of deposition dominated by the presence of carbonates. It is interpreted as a transgressive unit deposited under full marine conditions. The transgression does not imply unconformity and on the evidence presented it seems unlikely that there is unconformity between it and the Marino Group as proposed by Thomson and Horwitz (1961).

The Kanmantoo Group also initiates a new cycle of deposition and is marine, at least near its base, as indicated by the presence of brachiopods. The interfingering of the greywacke-shale sequence with the underlying Heatherdale Shale, suggested by Abele and McGowran (1959), cannot be supported, the Heatherdale Shale-Carrickalinga Head formation contact being one of the sharpest within the Cambrian sequence. The initiation of Kanmantoo Group sedimentation is interpreted as having commenced simultaneously everywhere within the region studied. Whether it is necessary to invoke a time break between the two formations to explain the absence of the non-calcareous member of the Heatherdale Shale at Carrickalinga

(3) A comparison of the stratigraphic column for the Stockyard Creek Precambrian sequence (fig. 1) with that given for the Willunga scarp by Madigan (1927, fig. 4) indicates striking lithological agreement between these two areas, provided due allowance is made for regional metamorphic effects. (As there is so little lateral lithological variation in the Cambrian-Precambrian succession on Fleurieu Peninsula there appears to be here an excellent research project for the metamorphic petrologist interested in the progressive metamorphism of a sedimentary succession.)

Head, is questionable. Rather, the initiation of its deposition may be related to the uplift (not orogenic) within the "geosyncline" during the Lower Cambrian (Daily, 1956, p. 99, pp. 125-128, p. 139).

IV. THE BASE OF THE CAMBRIAN SYSTEM, SOUTH OF ADELAIDE

Abele and McGowran (1959) discovered Cambrian fossils a short distance below the position of the Precambrian-Cambrian boundary as defined by Campana, Wilson and Whittle (1955). For mapping purposes they placed the boundary at the base of their *Hyolithes* sandstone and related all beds below this level to the Adelaide System.

Daily (1956), after discussing the problem of fixing the base of the Cambrian in South Australia, concluded that comparative faunal studies were necessary to define the base of the Cambrian and that "perhaps then we shall find that the base of the Archaeocyatha limestone will approximate the base of the Cambrian." These faunal studies have not yet been made and we are no further advanced towards solving this problem. Only comparative faunal studies of our oldest faunas with those from other continents, can provide a solution.

In any discussion on the boundary problem several factors must be considered before possible finality can be reached. We are not certain how far down in the stratigraphic column we will find Cambrian fossils. Perhaps our searches have in the past been too limited. Another factor already cited above concerns the environment of deposition and available conditions for fossilization. The Marino Group rocks have not been given the study they warrant and we can only guess as to their depositional history. Certainly they are not likely looking rocks in which to search for fossils. Nevertheless, fossils do occur and to these we ascribe a Precambrian age, not because we know they were Precambrian animals, but because the fauna is "without any known Lower Cambrian elements." (Glaessner, in Glaessner and Daily, 1959, Glaessner, 1960.) Another factor which clouds the issue is the proposed unconformity between the Marino Group and the Mount Terrible Formation on Fleurieu Peninsula. Unconformity or disconformity at the top of the Pound Sandstone in the Flinders Range has also been cited. Added to this the earliest shelly fauna on Fleurieu Peninsula contains such a variety of animals that one might expect to find traces of them lower down in the column. Further they may be older than Lower Cambrian faunas found elsewhere.

It has been the practice in this State to make time boundaries coincide with mapped rock unit boundaries. This is contrary to established stratigraphic principles and any attempt to define the base of the Cambrian as a rock unit boundary should be resisted. For this paper the Cambrian-Precambrian boundary is placed *within* the Mount Terrible Formation *below* the first appearance of the *Hyolithes* and associated fauna. Future study may decide that this position is incorrect but the boundary proposed is more realistic and compatible with known fact than one which is forced to fit the lithology.

V. THE AGE OF THE RAPID BAY MARBLE

Previous workers in the Rapid Bay-Delamere region have assumed the presence of only one major marble formation and have correlated this lithologically with the fossiliferous Lower Cambrian limestones found near Normanville.

The present investigations have shown that the sequence containing the Delamere marbles can be correlated with the Lower Cambrian succession both on lithological and faunal grounds. In addition, it has been shown that the marble on Stockyard Creek near Starfish Hill is not overturned but faces east, does not form the west limb of a postulated anticline of which the Delamere marble forms the east limb, nor is it Cambrian in age. It is about 2,500 feet stratigraphically below the Cambrian beds and equates with the Brighton Limestone and is therefore Precambrian in age.

Conformably below the marble are phyllites which can be correlated with the Tapley Hill Slate. These phyllites do not contain phosphatic nodules. The Jervis sheet indicates that these phyllites and marbles occupy a syncline between Starfish Hill and Mount Rapid and an anticline between Mount Rapid and Rapid Head. Continuity of outcrop is indicated for both units although in the hinge area of the syncline younger cover masks the marble. Investigations have suggested that the marble band on Mount Rapid is overturned and faces west whilst stratigraphically above is the "gritty marble" (Unit 33 of Stockyard Creek section) and other beds referred to the Marino Group, and below, beds lithologically similar to the Tapley Hill Slate. For these reasons the marble is correlated with the Brighton Limestone. If this band is then linked with the Starfish Hill marble as seems the logical thing to do, we would have an anticline with Tapley Hill Slate in the core but with closure to the north-east. This seems improbable as the closure of the regional anticline around the Yankalilla Archaean inlier is to the south-west. However, a fault bringing the two marbles close together could be postulated to explain the relationships. The closure of the Mount Rapid marble band with the large mass to the north, the Rapid Bay Marble, cannot be established, both bands being cut off by a fault west of Mount Rapid (Mr. R. D. Drayton, personal communication). If closure could be effected then we would have a syncline closing to the south-west which again is contrary to the structural interpretation of the region. No satisfactory facings have been found in the sequence below the Rapid Bay marble to assist in the interpretation of the complex structure but a few suggest that it is facing east and hence right way up. Possibly a fault separates the two marble bands[(4)].

It is impossible with the present data to establish the true stratigraphic position of the Rapid Bay marble. It still could be Cambrian in age but there are not many points of resemblance between these sequences and the established Cambrian sequence at Delamere. It is tentatively suggested therefore that the Rapid Bay marble is a tectonically thickened phase of the Brighton Limestone.

ACKNOWLEDGMENTS

Portion of expenses in connection with this work were defrayed from the University Research Grant. Most of the observations in the Sellick Hill-Carrickalinga Head region were made whilst at the South Australian Museum. I am indebted to Messrs. R. D. Drayton and W. C. Leslie for helpful discussions. They will contribute a joint paper with accompanying map on the geology of the Rapid Bay-Delamere region; also to other members of the Geology Department, especially Dr. A. W. Kleeman, who have criticized parts of the manuscript. I wish to express my sincere thanks to Mrs. H. Auvaart for typing the manuscript and to Miss A. M. C. Swan for the excellent drafting of fig. 1.

(4) The above arguments assume that the closure of the regional anticline to the south-west around the Archaean as mapped by Campana, Wilson and Whittle (1954, 1954a) is correct. The author believes that the evidence for a south-west closure might be disputed. Campana, Wilson and Whittle (1954a, fig. 3) in a block diagram indicate a closure for the basal conglomerates to the south-west around the Archaean. Mr. J. L. Talbot and the author have together examined the section along the Congeratinga River and found that the basal conglomerates occur as fault slices within the Archaean. Facings on all slices of these conglomerates proved that they were not overturned and belonged to the east limb of the fold and not the west limb as indicated. Further, the Sturt Tillite and underlying quartzites are faulted against the Archaean and are overturned (according to B.D.). Practically the whole of the thick pre-tillite sequence found on the east limb is faulted out.

If the regional closure for this anticline is to the north-east (a critical reappraisal of the region should indicate this), then many of the existing difficulties such as the faults postulated for the Rapid Bay region would become unnecessary.

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EXPLANATION OF PLATE 42

Fig. A. Cut and fill contact (chalked) between massive light-grey limestone of the Wangkonda Limestone (right) and the Sellick Hill Limestone, new Sellick Hill-Myponga road. Hyolithids occur abundantly above the contact in the Sellick Hill Limestone.

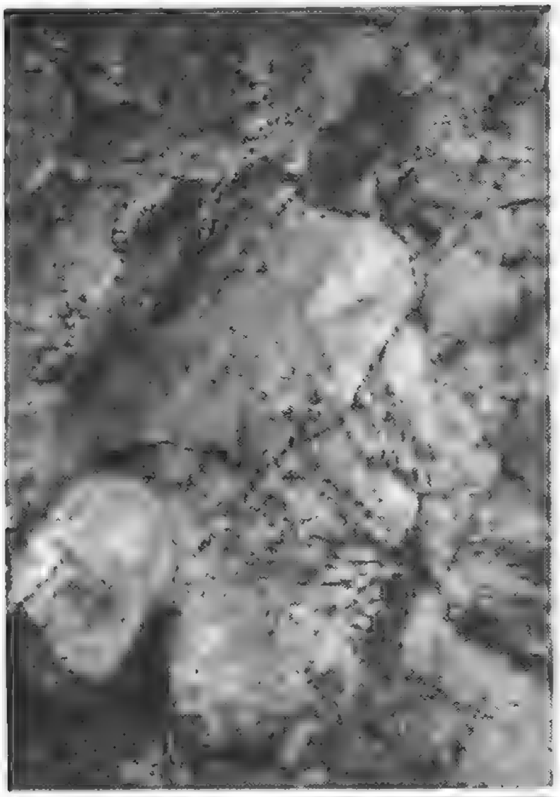
Fig. B. Contact between the fossiliferous Sellick Hill Limestone and the underlying massive marble (Wangkonda Limestone) in a small quarry, about 100 yards south of Stockyard Creek, Delamere. Hyolithids occur in sandstone at the contact indicated by the hammer head.

Fig. C. The cavernous weathering typical of the upper calcareous sandstone member of the Mount Terrible Formation, new Sellick Hill-Myponga road.

Fig. D. Cavernous weathering in the upper calcareous sandstone member of the Mount Terrible Formation, Stockyard Creek, Delamere. Hyolithids occur in beds about 4 feet above those in the photograph.

Photographs taken by Mr. J. L. Talbot, Geology Department, University of Adelaide.

A



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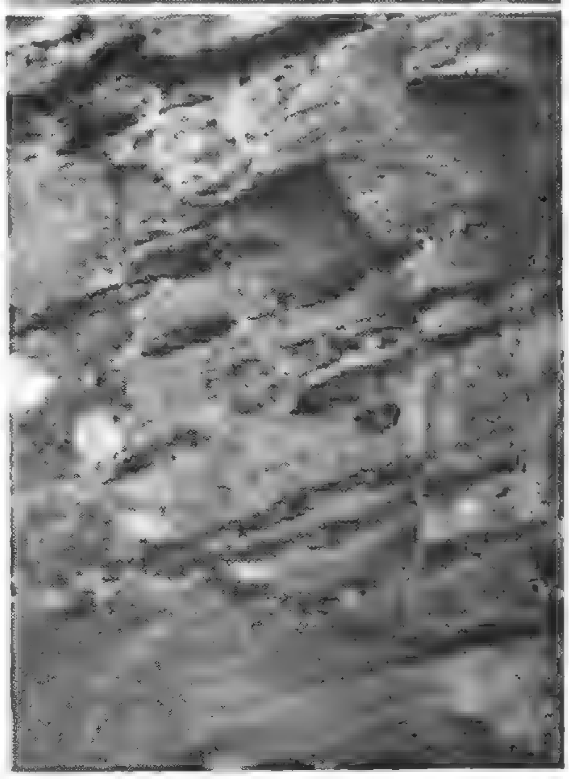

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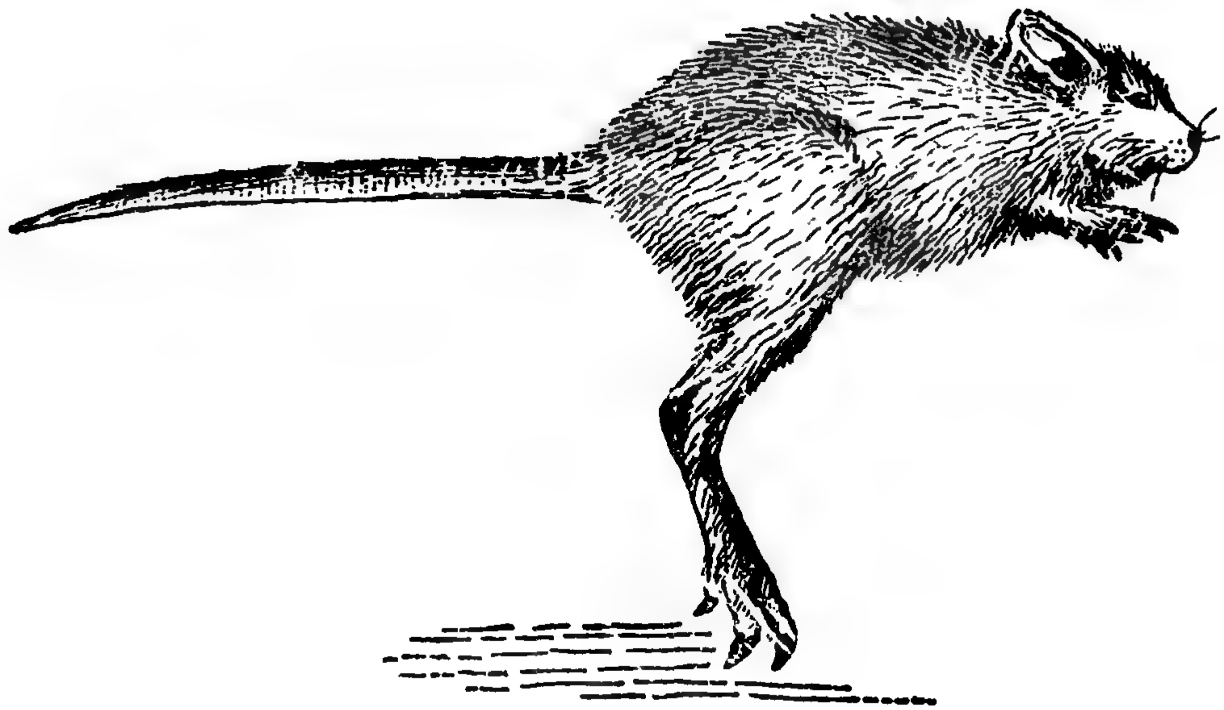
VOLUME 14 No. 4
1964



RECORDS
OF THE
SOUTH AUSTRALIAN MUSEUM

Published by the Board and edited by Norman B. Tindale

Printed in Australia by W. L. Hawes, Government Printer, Adelaide.
Registered in Australia for Transmission by Post as a Periodical.

OBITUARY NOTICE: HERBERT WOMERSLEY, A.L.S. (Honoris causa), F.R.E.S.

10.iv.1889-14.x.1962

(ENTOMOLOGIST, SOUTH AUSTRALIAN MUSEUM, 1933-1954; ACAROLOGIST, 1954-1959; HONORARY ACAROLOGIST, 1959-1962)

Summary

Herbert Womersley was born on April 10th, 1889, at Warrington, Lancashire, England. Warrington was an ancient town, an industrial centre with some 50,000 inhabitants, its most important industries being then the manufacture of iron and iron goods, wire, leather, soap and beer. It derived its importance from being situated on the River Mersey and the Manchester Ship Canal, an artificial watercourse separating Warrington from the county of Cheshire, and allowing large ocean-going vessels to reach the docks in the heart of Manchester. Warrington had a museum (which housed the free library) and a municipal art gallery. The town's moment of greatness was from 1757-1783, when the famous Dissenting Academy existed there, numbering among its teachers Joseph Priestley (1733-1804), also Aiken, Taylor and Wakefield.

Obituary Notice]

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Herbert Womersley was born on April 10th, 1889, at Warrington, Lancashire, England. Warrington was an ancient town, an industrial centre with some 50,000 inhabitants, its most important industries being then the manufacture of iron and iron goods, wire, leather, soap and beer. It derived its importance from being situated on the River Mersey and the Manchester Ship Canal, an artificial water-course separating Warrington from the county of Cheshire, and allowing large ocean-going vessels to reach the docks in the heart of Manchester. Warrington had a museum (which housed the free library) and a municipal art-gallery. The town's moment of greatness was from 1757-1783, when the famous Dissenting Acadamy existed there, numbering among its teachers Joseph Priestley (1733-1804), also Aiken, Taylor and Wakefield.

Womersley was a true son of Lancashire, and never quite lost all trace of the North Country accent. Apart from a short sojourn in South Wales, his boyhood was spent in Warrington, where he was educated. At an early age he became interested in insects, an interest no doubt fostered by his father, Fred Womersley, an enthusiastic amateur lepidopterist. Young Womersley's early interests in this group were the Lepidoptera, and later the Diptera. In his early twenties he became interested in microscopy, and had the good fortune to come in contact with Abraham Flatters, a well-known British microscopist, who was later one of the founders of the firm of Flatters and Garnett, makers of entomological requisites. Until the end of his life Womersley remembered Flatters with affection. Under his guidance, he was able to take a night course at the Manchester School of Technology in the staining, clearing and cutting of botanical sections. Out of this came Womersley's first scientific publication (1912), on the use of terpineol as a clearing agent, which was published in Flatter's own journal, *The Micrologist*.

In 1907 Womersley had joined the staff of J. Crosfield and Sons, soap and chemical manufacturers, where he served the equivalent of an apprenticeship, specializing in fuel economy (coal) and water

A

softeners. Before the 1914-1918 war he had begun to collect Diptera to some purpose, coming in contact with such well-known workers as A. A. Austen and F. W. Edwards. A number of new locality records were added to the British fauna, and notable among these was the collecting in Britain for the first time of the march-fly *Tabanus* (*Atylotus*) *plebijus* Fallen, 1817 in 1911 at Abbots, Moss, Delamere, Cheshire. His attention became at that stage attracted to the primitive insect groups, the Thysanura and more particularly the Collembola, groups in which he was able to make use of his flair for microscopy. He entered into correspondence with a number of other workers, both in England and on the Continent, including the Belgian workers M. Goetghebuer and A. L. Tonnoir, the latter of whom later came to Australia and worked with R. J. Tillyard in Canberra. (The present writer did not manage to find any of this early correspondence of Womersley's in the mass of material Womersley turned over to him in 1962, when a request was made for access to biographical material; possibly it did not survive World War 1.)

With the outbreak of hostilities, Womersley joined the Royal Army Medical Corps in 1914, initially through the St. John's Ambulance Brigade at Manchester. On account of his training in microscopy he was placed in charge of a laboratory at Fort Chatham, under the control of Charles Singer, later to become famous as a medical historian. Womersley's duties included routine clinico-pathological tests, including bacteriological, and even extended to routine pharmaceutical dispensing. A man of resource, no doubt he rose to the occasion under these varying demands. For some months Womersley was in daily contact with Singer, getting to know him and Mrs. Singer well, and on one occasion the trio journeyed to Folkestone together. Their love of natural history was no doubt a bond in common.

In 1915 calls were made for persons trained in chemistry to join the Chemical Corps of the Royal Engineers, and Womersley volunteered and was transferred to one of the newly formed gas companies. Womersley looked back in later life somewhat wryly upon this period. No real use was made of his training in chemistry, and the duties allotted to these troops consisted mainly of lugging heavy cylinders of chlorine, phosgene and other gases into suitable situations in the trenches, and, when the wind was suitable, releasing the gases upon the enemy. He participated in the first British gas attack upon the Germans at Loos, and again at the Battle for the Hohenzollern Redoubt, and on the Somme. These attacks were relatively ineffective, as the

Germans were well ahead in this field and had effective respirators. In addition the meteorological forecasts were unreliable, and the British gas companies sometimes found the gases they had released rolled back upon themselves when the wind changed. Womersley himself was affected by gas in this way on several occasions.

With the heightening tempo of war many industrial chemists were put into the munitions industry, Womersley being recalled from the trenches and transferred to explosives manufacture. Formal discharge occurred in 1917. He served in factories in Chester and Manchester, and later at Dornoch in Scotland, being concerned with the manufacture of T.N.T., nitroglycerine, acids, as well as the recovery of alcohol and ether vapour in cordite stoves. During this period there was no time for entomology.

In 1920 he left Warrington to take up an appointment as manager, Fuel and Steamraising Department, in Christopher Thomas Bros., soap manufacturers, at Bristol. He was now able to devote his spare time seriously to entomology, and entered into correspondence again with other workers. He worked with assiduity, concentrating upon the Apterygota, with an occasional incursion towards the Diptera and other groups. In the study of the Apterygota he found guidance in Lubbock's (1873) monograph on the Collembola in the Ray Society's volumes, and was also able to get help from a number of colleagues both in England and on continental Europe. For some years most help was probably derived from J. M. Brown, F.L.S., F.E.S., who identified Collembola and Thysanura sent to him in Sheffield. Others of his correspondents were J. R. Denis, of Dijon, France, W. M. Linnaniemi (who later changed his name to W. M. Axelson) in Scandinavia, Professor F. Silvestri in Italy, J. Stach in Poland, and the collembologists J. W. Folsom and H. B. Mills in the United States of America. His English colleagues interested in these insects were J. W. Shoebotham and R. S. Bagnall.

Womersley became closely associated with the Bristol Museum, his industry and enthusiasm impressing itself upon the then Director, Dr. H. Bolton. In Bristol also he identified himself with naturalists' interests. He joined the Bristol Naturalists' Society, taking a prominent part in its activities, including a term as President. He was also one of the promoters of the South-Western Union of Naturalists, and served as Secretary from its inception until he left England in 1930. His Presidential address to the Bristol Naturalists' Society in 1923 introduced his survey of the Apterygota of the south-west of England, which appeared in three parts, over 1924-1926. He was highly esteemed by his colleagues in Bristol, and on departure was made an Honorary Member of the Naturalists' Society. Cordial relations were enjoyed with many other naturalists, particularly entomologists, and the correspondence Womersley received from them remains in existence. The co-operation of these workers was both genuine and considerable, and these letters are a pleasure to read over 30 years later on the other side of the world. One finds among it such gems as this from the Rev. A. Thornley, M.A., F.L.S., F.E.S., F.R.Met.Soc., F.R.H.S., written from St. Anael's, Carbis Bay, Cornwall on 3rd September, 1929:

> ". . . Just at present . . . our little Bay, where I get your nice *Petrobius,* is almost a solid mass of trippers, and bathing tents right up against the Petrobial Cliffs!!! But as soon as ever they clear off to *dulce domum* my wife and I will make a special expedition and try to send you a tube-full . . ."

He did this despite his own preoccupation with the Diptera and other groups, his rheumatism and his age. In another letter he mentioned he had been an entomologist for 50 years.

Womersley had the capacity for lasting friendship, and another friend of that period who stands out is J. V. Pearman, who later joined the staff of the British Museum, specializing in Psocoptera.

In these years he published a number of short papers on the Apterygota, showing an increasing grasp of the group, and among these were sandwiched short notes on Diptera and Dermaptera. In the course of several years he became the British authority on Collembola, and collections were referred to him from South Africa, New Zealand, the New Hebrides and British Guiana for study, the last of these originating in the Oxford University's expedition there in 1929. His most important publication was a monograph upon the Collembola of Ireland (1930, Op. 34). That work was the result of collecting done in a long week-end in Ireland, which he spent in company with G. W. Stelfox of the Dublin Museum, a friend and admirer of Womersley. The collecting was done mainly in County Wicklow and around Dublin Heads, the trip being supported financially by the Royal Irish Academy, through its Fauna and Flora Committee; the Academy later published the monograph.

While still in Bristol Womersley became a Fellow of the Entomological Society of London (later F.R.E.S.), this being in 1926. He attended the meetings in London, going up from Bristol. The two occasions on which he attended a "Verrall Supper"—quite a famous institution—stood out in his memory in his old age. At these meetings he met such well-known entomologists as Karl Jordan and A. D. Imms. In 1929 G. P. Bidder, F.R.S., Zoological Secretary of the Linnean Society of London proposed him as an Associate, *Honoris causa,* of the Society, and Womersley won the keenly contested election for this honour, which he valued greatly.

In 1927 Womersley decided to transfer to entomology in a professional capacity as soon as opportunity permitted, and hoped to combine this with emigrating with his family to New Zealand. His abilities had by this time come to the notice of R. J. Tillyard, who was later appointed to the position of Chief, Division of Economic Entomology, C.S. & I. R. (later C.S.I.R.O.), Commonwealth of Australia. In 1930 Tillyard had Womersley appointed as Entomologist, Section of Pasture and Field Pests. At that time two arthropods were causing much damage to Australian pastures, the "lucerne flea" *Sminthurus viridis* (Linnaeus) (Collembola) and the Red-legged Earth Mite, *Halotydeus destructor* (Tucker, 1925); the worst infestations were in Western Australia. Owing to Womersley's lack of formal training in biology, at the university level, it was insisted that he was to spend a period of training in museum work. He was therefore posted to the British Museum from January to May 1930, for the purpose of getting as wide a knowledge as possible of the "group Acarina of the class Arachnida" and the "Order Collembola". As time was clearly limited, he was instructed to concentrate his attention upon two groups within the stated range, these being "the family Eupodidae [s.l.] of the Acarina" and the "family Sminthuridae" of the Collembola. His work was defined as being to complete as far as possible a catalogue of these two families, to study and collect material, both in the field and museums, making both slide and spirit collections, and mounts of dissected material. In the Collembola he was to concentrate on "the genera of the most economic importance, viz., *Sminthurus, Sminthurinus, Bourletiella,* and make microscopic mounts of as many species as possible". Furthermore, he was to:

> "Make a special study of the green and yellow species of *Sminthurus,* with a view to determining as accurately as possible the type characters of *S. viridis* L., and also of clearly distinguishing from it all the more closely allied species. This study should include the immature stages as far as possible, also careful measurements of adults of both sexes (*S. viridis* reaches a large size in Australia) . . .".

Finally, under "Control measures", Womersley was instructed by Tillyard to:

> "Draw up a report to me on the position in England at the present time as regards the mechanical, chemical and biological methods of control in use or being studied in connection with any of the above."

In a more personal note of the same date (January 3rd, 1930) Tillyard told Womersley that he had written to Dr. Tate Regan, then Director, British Museum (Natural History), asking him to provide every facility for Womersley's study in these groups. He asked Womersley to attempt to locate any of Stanley Hirst's type material in England. If he found it necessary he was to remain in England throughout the summer; this was to be decided after consultation with Dr. A. J. Nicholson, Deputy Chief of the Division, who was to visit England in May 1930. A fortnight later Tillyard forwarded a collection of mites and Sminthuridae, from Tasmania and other Australian localities, for Womersley's study, with the proposal that if the material were of sufficient interest the sminthurids were to be written up "in a very short paper entitled 'Clover springtails of Tasmania', with figures carefully drawn to show how the different species can be distinguished". All the material had been collected from clover species in the field.

In due course Womersley sent back the required paper. It was not published however, until 1932 (Op. 47), when the addition of fresh material necessitated some change of title. Womersley was able to list 32 species or subspecies of Collembola considered economically important in Britain. The same letter (undated, apparently May, 1930) refers also to MacLagan's studies on the possible control of *Sminthurus viridis* at Farnham Royal, as then unpublished (published in 1932, in the *Bulletin for Entomological Research*). Among predators observed by MacLagan were six species of spiders, five species of beetles, and one hemipteron (*Anthocoris* sp.). An additional note of Womersley's in the same letter to Tillyard is of interest, as heralding his eventual complete preoccupation with acarology:

> "I have now become very interested in the Acarina and am getting quite familiar with the different genera and more common species. What about the Tetranychidae (Red Spider)? Are these not of importance in Australia as well as the Eupodidae?"

On 6th March 1930 Tillyard wrote to say that all the formalities had been completed for Womersley's appointment with C.S. & I.R., for a period of three years. It is apparent that even at this early stage a considerable bond of mutual esteem and affection had developed between the two men. Tillyard had already commenced to send unofficial letters to Womersley, explaining the local background to him in a way which could not be dealt with in the more official correspondence. These letters are most revealing of the personalities of the two men, are helpful to the memorialist, and possibly also will be so to future historians. It is fortunate that this correspondence has been preserved. Tillyard wrote privately to Womersley on the 1st April 1930:

> "I should advise you to bend all your energies while in England to equipping yourself for your major problems, which are pretty tough ones, as you will readily admit. These other things [Devonian Collembola and insect phylogeny], interesting as they undoubtedly are, must be taken as *hors d'oeuvres* by those who sit at the Commonwealth[1] Banqueting Table! The tighter the finances grow, the louder will come the cry of 'Results, results, for our money!' And you know we simply cannot run without this money; so there we are! You will find the economic problems intensely fascinating on their own. The pure science must be developed more at leisure and in spare times."

After five months spent in training at the British Museum and in gaining familiarity with field control methods (from D. S. MacLagan, Farnham Royal, and W. M. Davies at Rothamsted), Womersley, with his family, left for Australia. As Dr. A. C. D. Rivett of the C.S. & I.R. had proposed, a short period was spent in South Africa *en route*, to make a study into the distribution and habits of *Halotydeus* ("*Penthaleus*"), and any other aspects that might be relevant to his duties in Western Australia. This pleasant interlude of seven weeks was greatly enjoyed, and Womersley was able to collect Collembola in various localities, and out of this was eventually to come his revision of the South African proturan fauna (Op. 45, 1931), the collembolan fauna (Op. 46, 1931; Op. 58, 1934), and also papers on the Thysanura (Op. 51, 1932) and Acarina (Op. 57, 1933; Op. 66, 1935), with the additional material from other collectors.

It was in South Africa that Womersley was thrown upon his mettle in economic entomology. He told the writer in 1961 that he also regarded this short period as his real introduction to the Acarina. Both in England and in South Africa his collecting of Acarina was very limited, and much less effective than his approach to the Collembola and the other Apterygota; probably also his interest

(1) of Australia, for those accustomed to a wider usage of this term.

in their taxonomy was not fully awakened. Thus the South Australian Museum collection of Acarina contains only a few slides of any other than the families Penthaleidae and Bdellidae (plus Cunaxidae) collected before he arrived in Australia. It was in South Africa that Womersley made his initial observations upon the predation of the bdellid mites upon *Sminthurus.* This the present writer has referred to in more detail in an account of Womersley's acarological work in "*Acarologia*"; it will not be repeated here. The letter to Tillyard, which preserves a record of these early studies on the subject, refers also to many other matters of entomological interest including some which Tillyard had brought up earlier, these being largely related to the distribution of the Protura and Collembola, the collecting of Psocoptera, and more particularly, the phylogeny of the insects, with which Tillyard was then greatly preoccupied. From this letter, as well as later ones, it is obvious that Tillyard was relying heavily upon Womersley for information on the structure and homologies of primitive and fossil insects.

Womersley and his family arrived in Perth on September 25, 1930. The hope that both Tillyard and Womersley had entertained of their meeting in Perth at the arrival was not fulfilled, owing to the financial stringency of the period, and the difficulties with which the Division of Economic Entomology, with Tillyard as Chief, had to contend. On arrival, the following letter was waiting from Tillyard, written on 18th September:

> "Unfortunately Australia's finances are just now in a parlous condition and are likely to remain so for some time to come. However, I have done my best to see that your work should not be hampered in any way by this circumstance, and a reasonable amount is still retained on the Estimates for your travelling about Western Australia looking at the Red-Legged Earth Mite and Clover Springtail or Lucerne Flea".

(Tillyard detested the common name "Lucerne flea" for *Sminthurus viridis* and made strenuous efforts to supplant this with "Clover Springtail"). In the same letter Tillyard elaborated:

> "To come . . . to your . . . research work, I expect you will find it convenient to divide your work on the Mite into sections under some such headings as the following:—
>
> (1) Distribution in Western Australia;
>
> (2) Control by natural enemies;

(3) Control by sprays and dusts;

(4) Control by cultural methods.

> "You will find that Mr. [L. J.] Newman, the State Government Entomologist, has already done a good deal of work under (3) and (4). We are hopeful that you may have discovered something under (2) in South Africa and that you may also have set up some kind of co-ordination with South African authorities which will enable supplies of it to be shipped to you from time to time. If not, then you will have to concentrate on other methods . . .
>
> "For second line researches, which may be undertaken when the main problem is hanging fire for any reason, I want you to look into the *Sminthurus* problem in Western Australia and also to collect and study Acarines, Collembola and related insects generally, paying special attention . . . to those likely to be of economic importance . . .".

Initially laboratory accommodation was made available at the Department of Agriculture, Western Australia, and after consultation with the Department Entomologist, L. J. Newman, Womersley was able to write to Tillyard on 30th September:

> "With regard to the Mite itself, from my talks with Mr. Newman it appears to be a far more serious problem here than in South Africa. I shall be able to say more about this later. It does not, however, appear to have been introduced here much more recently than the Cape Weed itself, which takes back to 1837[2], the mite not having appeared before 1916. Something like this may be the case in South Africa. Thus its association with *Cryptostemma* can only be secondary. Its possible mode of introduction, therefore, is still uncertain . . .".

In a more personal letter of the same date, Womersley (who had adopted this custom of Tillyard's), commented:

> "We are intensely taken with the fauna and flora here, and as we are on the edge of King's Park, I have a happy hunting ground at the very door"

(2) J. M. Black, in the "Flora of South Australia" (1929, 1957) records that *Cryptostemma calendula* (L. 1753) Druce, 1914 = *C. calendulaceum* (L. 1768) R. Br. 1818 originated in South Africa and was first collected in Australia at King George's Sound, Western Australia, in 1833. (The name of this species is now *Arctotheca calendula* (L. 1753) Levyns, 1942.)

and continued that it was proposed to use the Department of Agriculture laboratory as a town office, while accepting the offer of Dr. G. E. Nicholls of the facilities of his Department at the University of Western Australia for research, and possibly using Beverley, which he had not yet seen, as a field station.

> "If I work at the University and live near [as he was hoping] I shall be able to work out all my South African Apterygota there in the evenings . . . I found Protura in Capetown the weekend before we left".

The remainder of the letter discusses the phylogenetic relations of the insects with which Tillyard continued to be preoccupied, with the Devonian *Rhyniella*, the Protura, the Collembola and the Machilidae taking prominence.

By October Womersley had visited the Denmark, Guildford, Beverley and Bunbury districts, and was able to write a preliminary report on the presence of *Halotydeus destructor* and *Penthaleus bicolor* (Froggatt, 1921) (= *Penthaleus major* (Dugès 1834) (*teste* Womersley 1935d (Op. 67) p. 163) as being present everywhere in the State. By now he was living at Claremont, fairly close to the University, and was hoping soon to be able to devote some of his evenings to working there. Perth was to be the centre of his activities. Further Tasmanian Collembola were forwarded by Tonnoir, and Womersley set about getting all his Tasmanian material together for a paper to go in the *Papers and Proceedings of the Royal Society of Tasmania*. Tillyard, who was a member, had offered to communicate the paper for him.

By 3rd November 1930 Womersley was able to report that he had completed the study of the Tasmanian globular springtails. The same letter contained:

> "Now for some news! Protura have been discovered in W.A. Mr. Duncan Swan of the University has found them in humus in the University grounds. He has handed his mounts over to me for determination and verification. As he found them entirely by himself and only came to me for confirmation he is to be congratulated. They are a species of *Acerentulus* as are those that I was able to collect in S. Africa",

and continued that he had also received *Neelus* (= *Megalothorax*) from D. C. Swan in Western Australia, and had also a good many sminthurids from Western Australia, which he considered were mostly new. He commented on being unable to find the predators he had noted in South Africa:

> "The species of Bdellid and Trombid[3] which conditions in S. Africa suggested might be controlling predators, so far as present observations go, do not appear to occur here."

Tillyard (letter to Womersley, 15th November, 1930), in referring to the last sentence commented:

> "It is very important that you should let me know, as soon as possible, whether, after a more extensive survey of W.A., you are still of that opinion."

He further suggested that it might be desirable for these species of mites to be considered for introduction into Australia for study, in quarantine.

Another locality visited by Womersley was Bridgetown, where he spent 1st-4th December, 1930, and some collecting resulted.

On 12th January 1931 Tillyard wrote to Womersley stressing the importance of his finding out as much as possible about the eggs of both economic pests (the springtail and the mite) during the summer. He requested that Womersley should attempt to duplicate the findings of F. G. Holdaway, under varying climatic conditions, that in normal oviposition in *Sminthurus viridis* the animal defaecated over the newly laid egg with moist soil previously eaten, but to be on the alert for abnormal methods of oviposition:

> "I think that you ought at some stage duplicate this work under varying climatic conditions, so as to make quite sure that this habit is fixed in Western Australia, as well as in South Australia [where J. Davidson was studying the problem]. The climatic conditions are not altogether parallel, as you know".

Womersley replied to the effect that he hoped to do this. At the time he was working with great industry. In addition to his formal duties, he had under control a vast taxonomic programme for the Apterygota, and papers on these were in preparation or going through the press, dealing with members of this group from England, South Africa, Krakatau, Japan and Australia, and not long before he had

(3) At that stage Womersley used this term very loosely, *e.g.*, to cover the whole of the Trombidioidea and the Erythraeoidea. The mite concerned was probably a species of *Anystis* (Anystoidea: Anystidae) with whose identification he was not at that stage famliar. See the comments by Womersley (1933c, p. 111; Op. 57), under *Anystis baccarum* (L.).

published his accounts of the apterygote faunas of Ireland and New Zealand, and had dealt with various collections from Britain and elsewhere. At this stage his enthusiasm for the Apterygota was quite unbounded. In his letter to Tillyard of 15th February 1931 he wrote:

> "I am exceedingly interested to hear of the species of Collembola from Mt. St. Bernard [Victoria]. Fancy asking me if I would like to see it! . . . I am only too keen on seeing Springtails from anywhere on this earth or the next if they exist there".

The voluminous correspondence between Womersley and Tillyard continued for several years, and provides many an illuminating commentary on the time and on their colleagues, as well as upon their own attitudes and working methods. The mutual esteem and affection were quite genuine, and due to a natural affinity of character. The bond was cemented further when Tillyard was able to visit Womersley in Western Australia.

The love of both men for their subject shines through this correspondence. Tillyard, through his access to the higher circles of government, writes more revealingly. He was clearly quite perceptive, and a good judge of character. We find this comment in a letter to Womersley, written on 15th October 1931:

> "The other day we had an interesting visit from the M.P. for Fremantle, Mr. J. Curtin. I found him an exceedingly well informed and interesting man, and ventured to mention you to him, whereupon he said that he was shortly returning home to do some work in his electorate, which is by no means a safe one for him, and that he would look you up! So do not be surprised if he calls round at Marita Road [Claremont], as you are actually in his electorate. He is a very brilliant debater and a most interesting personality; quite good enough to be in the Ministry, I think. I hope you will do your best to interest him in your particular problems if he comes along."

Being in high position in Canberra, Tillyard realized the importance of the political aspects of economic entomology far more than Womersley could in Western Australia. The politician John Curtin became Prime Minister in 1941.

Womersley continued his work for nearly three years with the Division of Economic Entomology, when his appointment was drawing towards completion. Unfortunately, the period of financial stringency which Australia had been undergoing had not abated, and although the work was considered promising, all appointments were being terminated as soon as contracts were completed. Although Womersley had hoped to continue his work under Tillyard, such was not possible, and he applied for the position of Entomologist, South Australian Museum, which had become vacant with the death of Arthur M. Lea. With Tillyard as his champion, Womersley had no difficulty in getting this appointment. Although he had not given up hope of working under Tillyard again (with the added attraction that the C.S. & I.R. salaries were well above those offered in South Australia), it was in this position that his major contribution to science lay, and he stayed there until his retirement, and subsequently. Nevertheless, it was considered that the work on the predator control of *Sminthurus viridis* was most promising, and Tillyard subsequently set G. A. Currie to continue in the field which Womersley had pioneered, and after Currie had left this work, another officer, K. R. Norris, was also given this field of study, and other studies have continued subsequently.

What had Womersley actually achieved in his work for the C.S. & I.R. in Western Australia? As Tillyard's early correspondence indicated, the study of the possible chemical and cultural methods of control of *Sminthurus* and *Halotydeus* had been pursued previously, notably by L. J. Newman. The study of the actual life history of *Sminthurus* was under study by J. Davidson in the Waite Institute in Adelaide, with effective and extensive equipment, also technical and other assistance. Davidson was not in the position of being under pressure to solve a major task affecting an area as large as Europe. In collaboration with the Western Australian Department of Agriculture, though with limited finances, more precision was given to the knowledge of the chemical attack upon the pests. The new aspect was the study of predator control of one of these pests, *Sminthurus*. These results were summarized in two papers (Op. 50, 1932; Op. 53, 1933), in which guarded claims were made. Methods of transporting the predator mites were studied, and attempts to establish them in various pastures were made, which were considered successful, although criticism is possible of the methods adopted, there being no experimental design that would provide sufficient evidence for firm conclusions to be drawn. In fairness, however, it should be realized that a technical service for this was not really available, nor were its potentialities capable of being applied under the circumstances as they were then. It is doubtful if the taxonomy of the Australian Bdelloidea was at a stage advanced enough to be an instrument of precision. From a long range viewpoint, among the more important results of the work were the numerous taxonomic papers Womersley produced on the Collembola. Among these was his Opus 52 (1932), a preliminary account of the Australian Collembola, published as a pamphlet by the C.S. & I.R. It is notable in another regard, in being the first taxonomic paper ever published at the expense of the C.S. & I.R., through the Division of Entomology.

In subsequent years large batches of the predatory bdellid mite, *Biscirus lapidarius,* were sent to localities in other Australian States, where there was a heavy infestation with *Sminthurus.* In the absence of sufficient finances to do fully controlled experimental trials, it was considered that this was the most effective means of testing out the effect of this predation. Initially hundreds, and later, thousands of mites were sent, and were placed at Riverton, Murray Bridge, Glen Osmond, and Woodside in South Australia, as well as in Victoria and Tasmania; also earlier in Western Australia (see Op. 53). In this work Womersley acted in a consultative capacity on the taxonomy of the Collembola and of the mites. These activities by the C.S. & I.R. continued for some years. Over 1934-1936 increasing claims were made for the effectiveness of this method. By 1937 newspapers were carrying headlines, claiming that the bdellid mites had controlled the "lucerne flea", written in a florid journalistic style. In fairness to Womersley it should be pointed out that he was in no way responsible for these widely publicized and perhaps exaggerated claims, and this blaze of publicity was not of his designing. Although gratified that his work should be considered a success, he remained unmoved by it, at least outwardly, and continued his taxonomic work without interruption. His friend and colleague, D. C. Swan, wrote in 1940 (*J. Agric. S. Austr.* 43: 466) that the results of predator control of *Sminthurus* were not striking, possibly with the newspaper treatment of the subject in 1937 in mind. K. R. Norris, who had taken up the subject for C.S. & I.R. in Western Australia, studied the subject for several years, and concluded (1938, C.S. & I.R., Pamphlet 84):

> "The population graphs for *Smynthurus*[4] *viridis* may differ widely for different situations and also for the same situation in successive years. The numbers of *Biscirus lapidarius* are shown to have a probable relation to those of *Smynthurus,* accounting at least in part, for a rapid decline in the number of springtails at the end of the season."

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(4) The name *Sminthurus* has now been placed on the Official List of Generic Names in Zoology (1954), and *Smynthurus* is invalid and rejected (1958).

A further appraisal of this subject will be found in Wallace, M. M. H., *Austr. J. Agric. Res.*: 1954, 5 (1): 148-155, and 1959, 10 (2): 160-170. These papers will give further references for those interested in this subject.

Womersley took up his duties at the South Australian Museum on January 1st, 1933. He worked there until the end of his life, although at times he considered the possibility of moving to London, or elsewhere in Australia. It is fortunate for the taxonomy of the Australian Apterygota and Acarina that he did not do so, as it is unlikely he would then have been able to devote himself so wholeheartedly to these tasks. Initially he concentrated on the taxonomy of the Apterygota, producing a large number of short papers, and in 1939 published "The Primitive Insects of South Australia" in the British Science Guild Handbooks series, where, in actual fact, the whole of the Australian Apterygota, as then known, were monographed.

In 1932 he published a short note with L. J. Newman (Op. 50) in which he made his first reference to the Acarina in print, and in 1933 published three papers (Opp. 53, 56, 57) in which Acarina were considered. Rapidly, more extensive inroads into the taxonomy of the Acarina were made. The story of Womersley's acarological studies has been told in *Acarologia* (5 (3): 323-334) of July 1963, and therefore will not be elaborated here. It may be said however, that the collection of Acarina at the South Australian Museum is one of the great collections of the world, and his series of papers on the taxonomy of the Acarina have seldom been equalled. His *magnum opus*, over his whole field of work, was undoubtedly his monograph of the Trombiculidae of the Oriental and Australasian regions, published in the *Records of the South Australian Museum* in 1952 (Opp. 138, 139). It ran to 673 pages. Gradually, as the immense collections of these Acarina, the vectors of scrub typhus, and related forms kept being referred to him, all groups other than mites were dropped from his studies. Once that major work was completed he was free to produce a long series of shorter papers.

He retired in 1954 as Entomologist, but was immediately appointed as Acarologist, a position that had been created specially for him. At the age of 70 years, in 1959, he retired again, but became Honorary Acarologist, and worked on as before. By now he was dogged by increasing ill-health, and could not work such long hours. He continued the study of his beloved Acarina until a fortnight before his death. In the Apterygota, and more particularly the Acarina, his industry and regular habits enabled him to produce an immense amount of work, and he did a great deal for descriptive taxonomy, where his services will be greatly missed.

He was also active in scientific affairs in England and Australia, particularly on the organizational side and in the field of wild-life conservation. This is referred to in more detail elsewhere (Trans. Roy. Soc. S. Austr., Adelaide, 87: 249-252 (1963)). He was the Verco Medallist of the Royal Society of South Australia in 1943, served as President in 1943-1944, and was gratified by the Society's electing him to Honorary Fellowship in 1962.

ACKNOWLEDGMENTS

The writer wishes to acknowledge Womersley's own help in providing biographical details when requested in 1961 and 1962, and in providing information and correspondence, particularly of the period before 1933. In addition the letter files of the South Australian Museum have been consulted in particular points. The correspondence of 1923-1932, and also some of subsequent years, which Womersley entrusted to the writer, will be deposited later in the South Australian Archives.

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(5) There is some difficulty in establishing the order and date of publication with some papers. The estimates given are the best after considering all the evidence available to me. Month of publication is estimated similarly, where available.

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R. V. SOUTHCOTT

ABORIGINAL FACTORY SITES AT MOONEE BEACH, NEW SOUTH WALES

By W. I. North, M.B.B.S.

Summary

This paper records a site at Moonee Beach, on the coast of New South Wales (153° 40´ E. Long. X 30° 10´ S. Lat.), where wind erosion has revealed an ancient aboriginal factory-camp. The implements are principally pebble choppers, together with a small proportion of edge-ground axes, the latter being concentrated in a relatively confined area, suggesting the possibility of more than one period of occupation. Notes on another minor site are included.

One of the implement types, believed to be new, is described herein as the Moonee Adze.

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Fig. 1-8

SUMMARY

This paper records a site at Moonee Beach, on the coast of New South Wales (153° 40′ E. Long. x 30° 10′ S. Lat.), where wind erosion has revealed an ancient aboriginal factory-camp. The implements are principally pebble choppers, together with a small proportion of edge-ground axes, the latter being concentrated in a relatively confined area, suggesting the possibility of more than one period of occupation. Notes on another minor site are included.

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THE SITES

The area was discovered by the author while on holiday in July 1959, revisited in January 1962, and in May and July 1963. From the south end of Moonee Beach the extensive wind-eroded dunes, about three miles north, could be clearly seen with binoculars. Access was at that time difficult, but as a housing estate is being opened up on the adjacent headland, roads are now being laid almost to its edge.

Site I is situated at Part Lot 44, Parish of Moonee, County of Fitzroy, at the northern end of Moonee Beach, 12 miles north of Coffs Harbour and about one mile east of the Pacific Highway. The road turn off to the site is exactly beside the 400 mile post from Sydney.

The site consists of an extensive area of wind-eroded high dunes situated immediately behind the present 12 to 15 foot beach dunes. These inner fixed dunes are covered by low bushes. Where intact, they are 30 to 40 feet high and where deflation has taken place show a layered implement-bearing midden horizon some 10 or 15 feet below their former summits. The moving sand has buried the heavily wooded scrub as far as a 150 yards inland, and exposed an implement bearing area approximately 400 yards long and 70 yards wide; roughly six acres in extent (fig. 1 and 2).

Towards the beach no implements whatever occur below the 10 foot terrace or in the 15 foot dunes bordering the present sea-shore.

Site II is much smaller, occupying an area of less than two acres. It is situated on the narrow neck of a headland about two miles north of Site I, and four miles south of Woolgoolga (fig. 3). It is

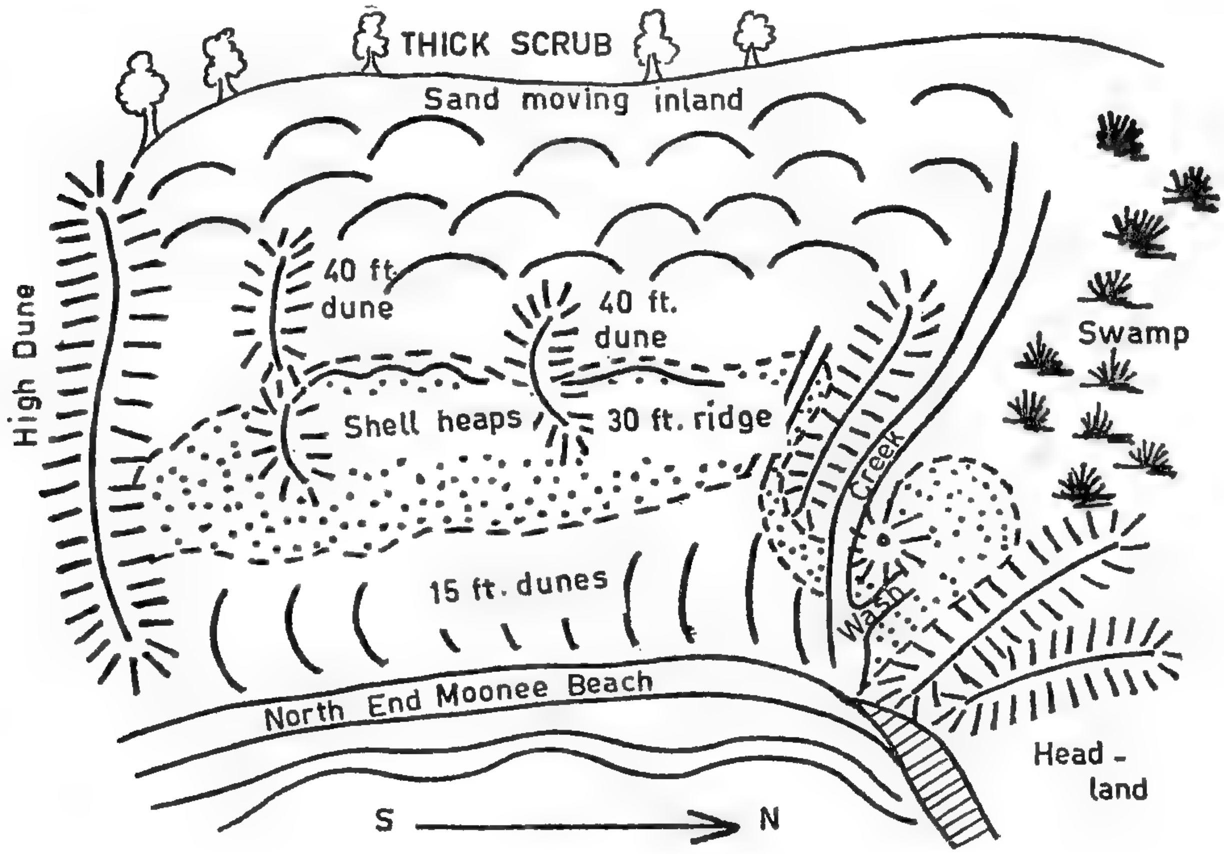


Fig. 1. Ground plan of Site I at Moonee Beach, New South Wales.

approximately 100 yards long and 50 yards wide. High fixed dunes border its landward side. The implements lie on the basic ironstone ridges of the peninsula and on sand remaining in the central parts. Water has washed some towards the beach, otherwise again no implements occur lower than the 10 foot level. They are the same in type and relative numbers as those of Site I, and are classified together. Most ready access to this site is by walking along the beach from Site I.

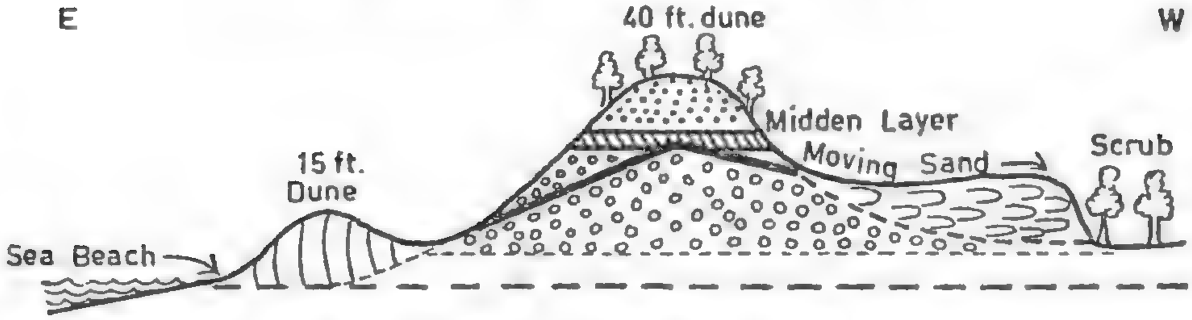


Fig. 2. Elevation (not to scale) of Site I. (Heavy line indicates implement horizon; heavy dots sand cover; circles indicate old fixed dune).

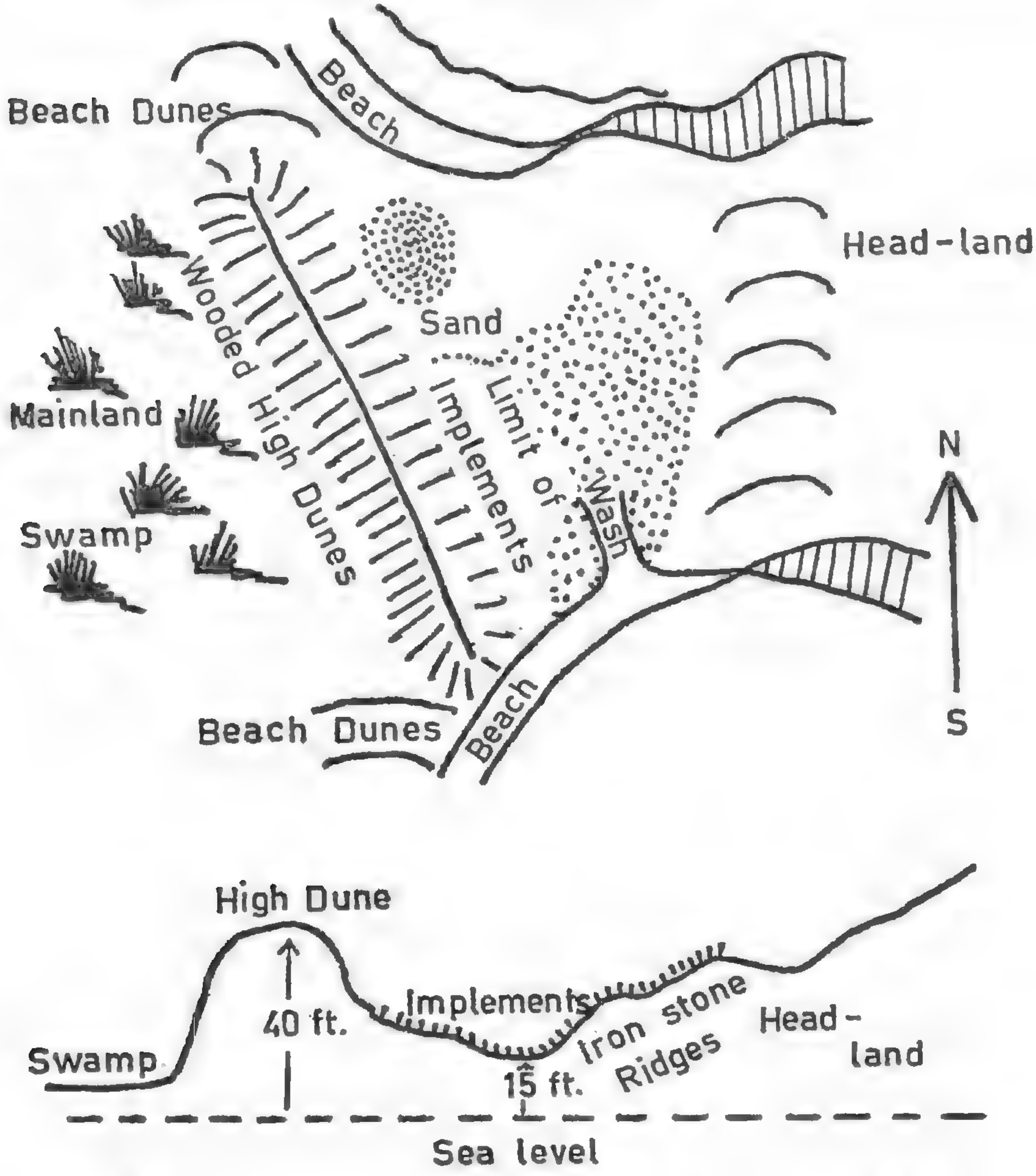


Fig. 3. Plan and elevation of Site II at Moonee Beach, New South Wales.

STONE MATERIAL

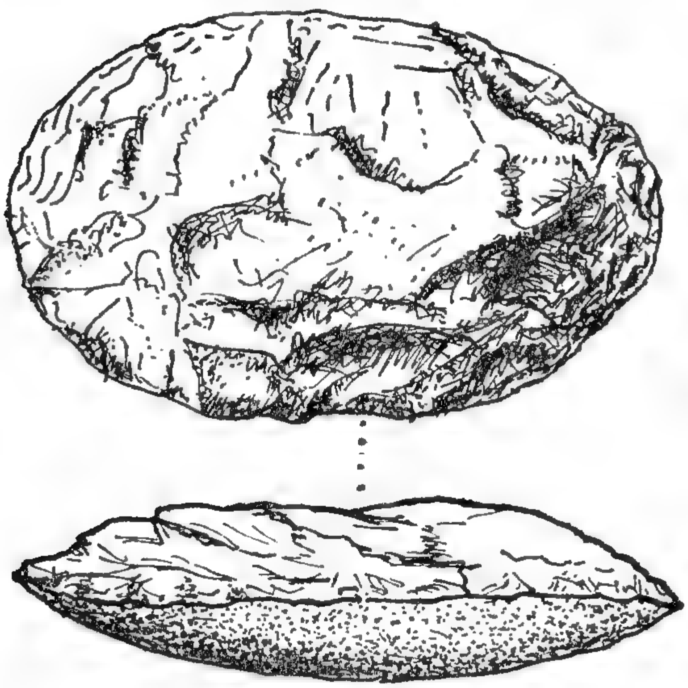
All implements found on the sites are made from pebbles, mainly fawn to dark gray silicified mud, silt and sand-stone, with a few specimens of fine and coarse clastic greywacke. One fine quartz side chopper was found. There is an abundance of these large and small water-worn pebbles available locally at the junction of the beaches and headlands along this coast.

IMPLEMENTS

The following is a classification of the implements found at these two sites, with some notes on those of particular interest.

Edge-Ground Axes: 18—3% of total.

Heaviest—1,200g. (2½ lb.).
Lightest—240g. (½ lb.).
Average weight—720g. (1½ lb.).



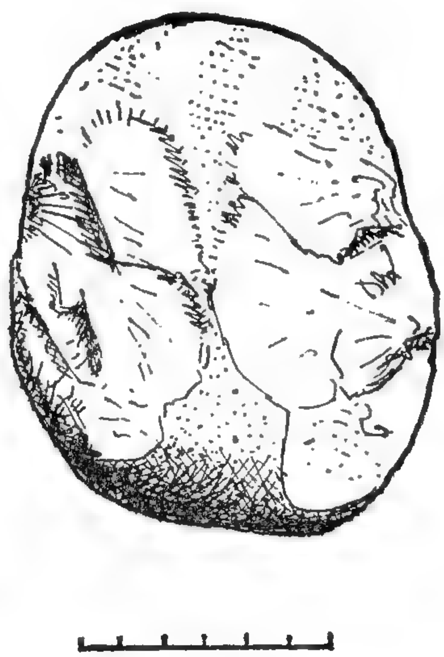


Fig. 4. *Sumatra* type implement, Moonee Beach. (In this and succeeding figures the scale is to be read in centimeters.)

Fig. 5. Edge ground axe of *windang* type, Moonee Beach.

Types: 16 roughly flaked one side, the so-called *windang* axe; 2 flaked on both sides, biface ground (fig. 5).

The two last named closely resemble the typical axe of south-eastern South Australia.

Stone material: 16 of mud- or silt-stone; 2 of greywacke.

Some of these axes are well preserved, others are rather sand-blasted and weather worn.

Side-Flaked Pebble Choppers: 340 + estimated 100 remaining on sites—70% of total (fig. 6).

Heaviest—1,680g. (3½ lb.).

Lightest—150g. (5oz.).

Average weight—465g. (15½oz.).

Types: 15 also flaked at one end; 2 also flaked at both ends.

Stone material: Elongated pebbles of mud- and silt-stone, mostly in very good condition, a few of soft sand-stone are well weathered (fig. 6).

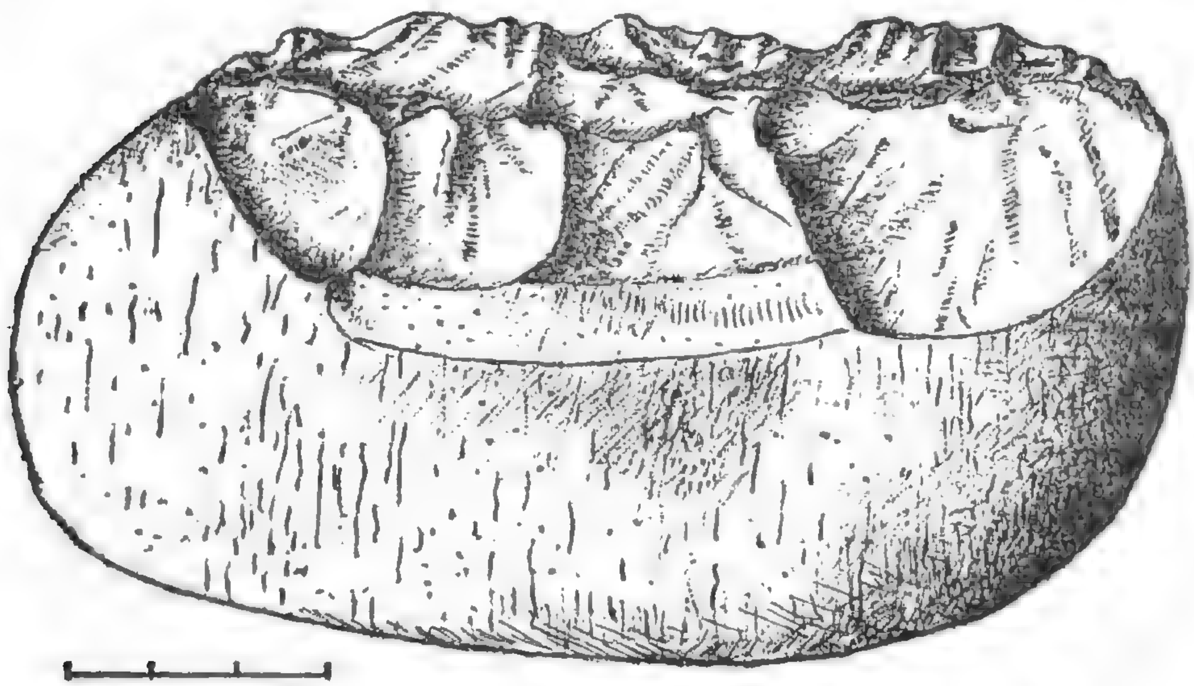


Fig. 6. Side-flaked pebble chopper, Moonee Beach, New South Wales.

End-Flaked Pebble Choppers: 68—10% of total.

Heaviest—540g. (18oz.).

Lightest—105g. (3½oz.).

Average weight—300g. (10oz.).

Types: 5 also flaked on both margins (fig. 7); 1 flaked at both ends on opposite sides.

Stone material: Ovoid flat pebbles of grey silt-stone.

SUMATRA TYPE: 32—5% of total (fig. 4).

Heaviest—1,800g. (3¾ lb.).
Lightest—420g. (14oz.).
Average weight—720g. (1½ lb.).

These were generally well made, typical "sumatras", in good condition. Two showed a cortical remnant on the worked side.

PLANES: 7—1% of total.

Average weight—840g. (1 lb. 12oz.).

Type: Upright "horsehoof" nuclei. Two had a right angle curved base.

MISCELLANEOUS CHOPPERS: 20 + —3% of total.

This ill-defined group comprises biface and uniface irregularly flaked pebbles, coroids and slices. Some are heavy, with large percussion bulbs and step flaking along several edges and were probably fabricators. Others are long "pick" type implements with a pointed end worked on both sides. Many showing some flaking and fracture may be rejects.

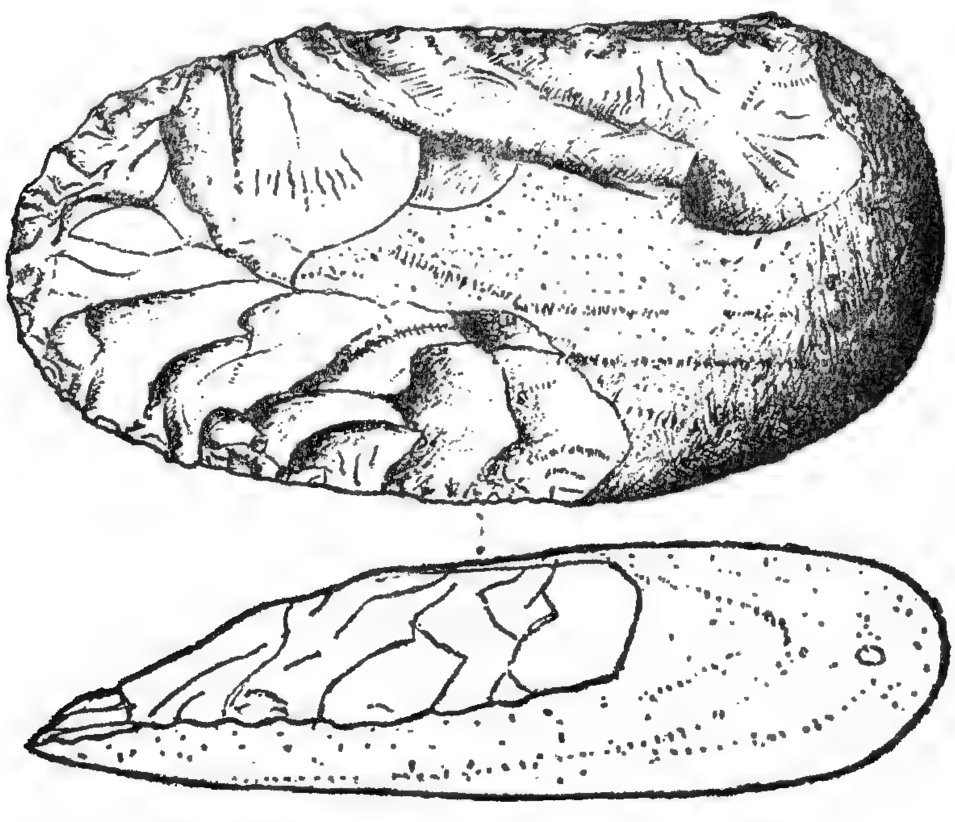


Fig. 7. End-flaked pebble chopper, Moonee Beach.

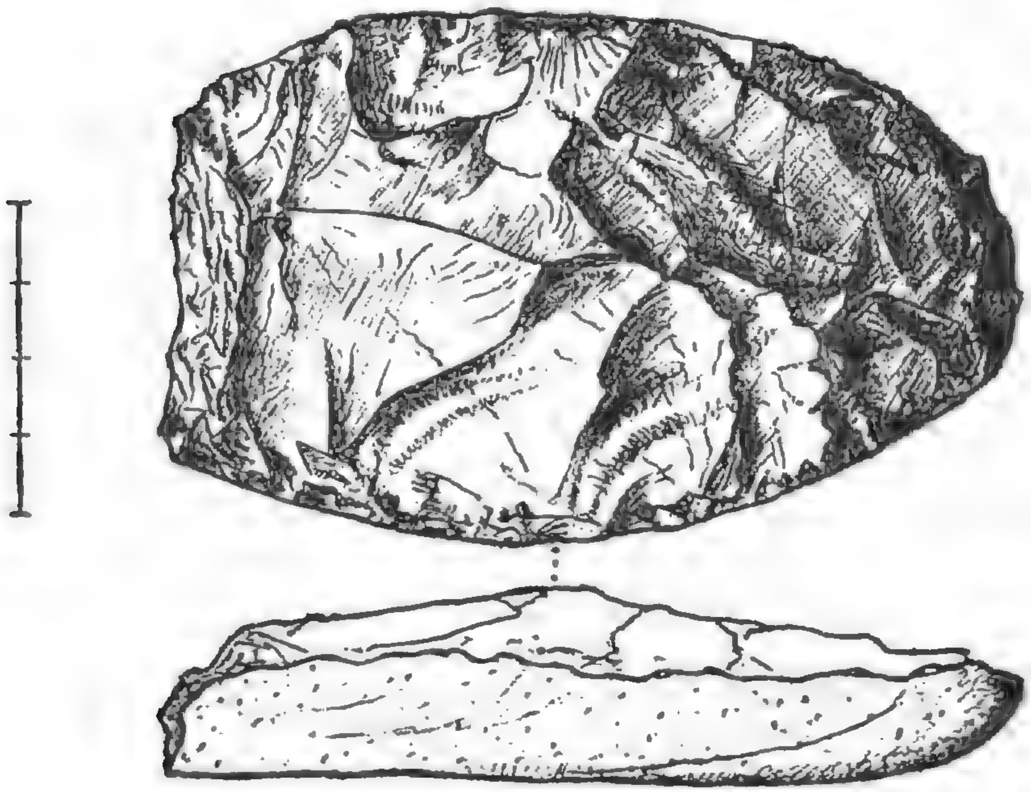


Fig. 8. *Moonee adze.* Moonee Beach, New South Wales.

MOONEE ADZE: 55—8% of total (fig. 8).
Weight from 50g. (1.6oz.) to 240g. (8oz.).
Length from 7 cm. (2.7in.) to 12 cm. (4.7in.).
Width from 4.5 cm. (1.8in.) to 6.8 cm. (2.7in.).
Maximum thickness from 8 mm. (0.3in.) to 26 mm. (1.0in.).
Average weight—110g. (3.75oz.).
Average length—9.5 cm. (3.75in.).
Average width—5.5 cm. (2.15in.).
Average maximum thickness—15 mm. (0.6in.).

Stone material: Hard light gray to black mud-stone.

This interesting and extremely well made implement, of which I have not seen a previous description, has been for obvious reasons called the "Moonee Adze".

It consists of a flat oval pebble or slice fully flaked on one side only, with secondary flaking along the margins. Twenty-five of these were found intact. The remaining 30 showed varying degrees of reworking by step flaking at one end, up to three-fifths of the original oval being flaked away. Four were worked back at both ends. A typical but large specimen is illustrated as fig. 8.

These implements were made either from a very flat pebble or from a thin slice from the flat side of a large stone. In three specimens a small area of cortical surface remains near the centre of the worked side, and in two others a definite percussion point and bulb can be seen midway along one lateral margin.

In spite of the wide disparity in size of the whole series, by far the greater proportion of specimens conform closely to the average measurements noted above, namely an implement of just under four ounces in weight, four inches in length, two in width and half an inch thick, tapering off flatly to all margins on the worked side.

An interesting series can be shown with all degrees of wear from the initial stages right back to the extreme two-fifths remnant. From this fact, and from its unsuitable shape, if used as a hand tool, arises the suggestion that this implement may have been used as a mounted adze in the manner of the resin hafted *tula* adze of Central and South Australia and that the hafting medium covered two-fifths of the stone.

The distribution of the Moonee adze and the edge-ground axes was limited to two relatively small areas on Site I and one on Site II, whereas all other implements were scattered indiscriminately over both sites.

The high proportion of intact specimens may be due to the fact that these sites were factories as well as camps. Several unworked, partly worked or broken slices and pebbles were found of the dark stone used in making the Moonee adze.

OTHER REMAINS

Ochre: Red and yellow lumps up to 12oz.

Quartz Crystal: One large example.

FOOD REMAINS

Shells lie scattered thickly over both sites, mainly pipis, whelks and turban shells.

In addition, rather disintegrated midden bases occur, a small one on Site II and a larger area on Site I. These are situated along the 25 foot ridge connecting the remaining fixed dunes and may be indicative of the original camp level. Different shells predominate in heaps along this ridge from north to south in this order—pipis, periwinkles, small oysters and mud whelks. In all, the following shells were identified:

Ninella torquata (Sydney Turban).
Plebidonax deltoides (Pipi).
Pyrazus ebeninus (Mud Whelk).
Saxostrea commercialis (Rock Oyster).
Dicathais orbita (Cart rut Purple).
Melanerita melanotragus (Periwinkle).
Cellana tramoserica (Limpet).
Patellanax peroni (Limpet).
Scutus antipodes (Elephant Snail).
Cymatilesta spengleri (Triton).
Cymbiola rutila (Volute).

A little charcoal and calcined bone from a midden was collected.

NOTES AND COMMENTS

Whole pebbles, split pebbles, rejected flakes, partly made implements and broken ones lie in profusion everywhere.

There were no microliths, points, segments, cutting tools, pounding or mill stones occurring on either site.

There is little evidence of secondary use on any tool, in particular on the side choppers which comprise 70 per cent of the total. These implements resemble the Kangaroo Island specimens collected by Mr. H. M. Cooper, except that they are generally narrower and lighter, and show few examples of use at either end concurrently with the side, and no examples of subsidiary use as hammer-stones. Only one pebble showing percussive pitting was found, and this was otherwise unworked.

Some of the side choppers are similar to the historically known choppers for *bungwall*-fern-root-gathering reported by Jackson (1939) from the Kabi tribal area of Southern Queensland.

Fresh water is available in adjoining springs and swamps behind each site.

From local information it was learnt that the Jita-Jita people occupied this general area about 100 years ago. They were a branch of the Kumbainggiri tribe which extended from the Clarence or the Richmond River south to the Nambucca. It is believed also that at certain times of the year inland tribes came over the mountains and were given access to the local foods, in particular to the fleshy dicotyledonous seeds of the mangrove and the large shoals of sea mullet passing along the beaches.

A representative series of the implements listed herein has been lodged in the South Australian Museum, where data is available under the number A.54565.

The evidence shows so far that the implements are associated only with the old fixed dunes, thought to be those formed 3,700 years ago or earlier. Implements are *in situ* in the highest parts of the eroded ridge and can also be seen buried in the upper slopes of the old dunes in association with blackened sand and shell remains.

It was considered worthwhile, therefore, before carbon fourteen dating with its attendant delays can be applied, to publish this article.

ACKNOWLEDGMENTS

In the preparation of this paper I wish to acknowledge with thanks the help of the following persons: Mr. Norman B. Tindale, Curator of Anthropology, South Australian Museum; Dr. D. Corbett, Geologist, South Australian Museum; Dr. H. M. Laws, Conchologist, South Australian Museum; and Mr. G. England of the Coffs Harbour Historical Society.

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ROCK ENGRAVINGS AND STONE IMPLEMENTS OF PITCAIRN STATION, NORTH-EASTERN SOUTH AUSTRALIA

BY ROBERT EDWARDS

Summary

This paper describes the rock engraving sites on Pitcairn and adjoining Hill Grange stations in north-eastern South Australia. The sites and their distribution are defined and considered in relation to topography. The marked weathering of the rocks and the engraved surfaces is discussed. Associated camp-sites and the stone implements collected from them are briefly described. Typical examples of engravings and implements are figured; evidence of considerable antiquity and of engraving techniques is given.

ROCK ENGRAVINGS AND STONE IMPLEMENTS OF PITCAIRN STATION, NORTH-EASTERN SOUTH AUSTRALIA

By ROBERT EDWARDS

Plates 43-45 and text fig. 1-9

SUMMARY

This paper describes the rock engraving sites on Pitcairn and adjoining Hill Grange stations in north-eastern South Australia. The sites and their distribution are defined and considered in relation to topography. The marked weathering of the rocks and the engraved surfaces is discussed. Associated camp-sites and the stone implements collected from them are briefly described. Typical examples of engravings and implements are figured; evidence of considerable antiquity and of engraving techniques is given.

INTRODUCTION

Early in 1962, a field excursion to Pitcairn station (map, fig. 1) was made by Professor G. H. Lawton, Department of Geography, University of Adelaide, Mr. C. P. Mountford, Honorary Associate in Ethnology, South Australian Museum, and the author, to record a group of rock engravings at a locality known by the station owners as the Twelve Mile. The discovery of jaw fragments of a *Procoptodon* or Giant Kangaroo in the bank of a local creek by Brian K. Sawers, one of the owners, had first drawn attention to the area as meriting examination.

Subsequent investigation by the author revealed other rock engravings and camp-sites. These relics of aboriginal occupation form the subject of this paper.

LOCATION

Pitcairn station, about 170 miles north-east of Adelaide, occupies an area of 180 square miles fringing the semi-arid parts of South Australia. The average rainfall of approximately eight inches is usually associated with thunderstorm conditions.

The largest watercourse on Pitcairn station is the Manunda Creek which collects the run-off from Porcupine Range (plate 43, fig. A), dominant geographical feature of the area. This range is rugged and steep, its highest point, Waite Hill, being 2,405 feet above sea level. There are a number of shelters among the outcrops of rock on the slopes of the range, but examination failed to reveal evidence of prolonged aboriginal occupation.

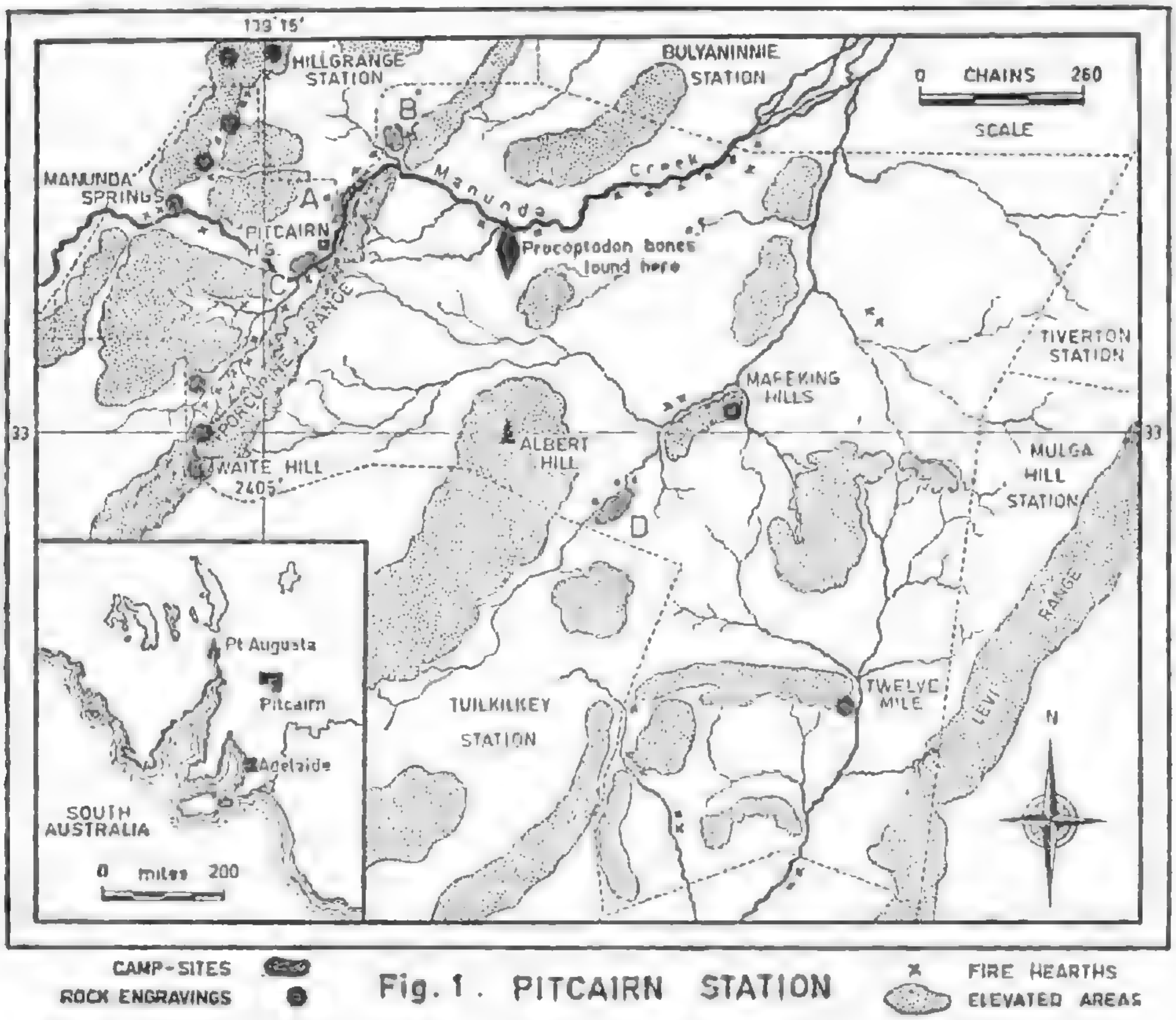

Fig. 1. Map of Pitcairn station indicating the relative positions of rock engravings and camp-sites.

WATER SUPPLIES

A permanent running spring in the bed of the Manunda Creek (map, fig. 1) provides a good supply of fresh water. Smaller semi-permanent springs in the steep gorges of Porcupine Range (plate 43, fig. C) and rockholes, some capable of holding many gallons of water, occur on the stony hills of both Pitcairn and adjoining Hill Grange station. The openings of some of these rockholes have been covered with flat slabs of stone, probably by the aboriginals, to prevent animals drinking the water, and to reduce contamination and evaporation.

FLORA AND FAUNA

The flora of the area, characteristic of the dry parts of South Australia, appears to be a northerly extension of the Murray belt of scrubland. The eucalypts are, for the most part, the dwarf varieties generally classified under the name "Mallee". Scrub Sheoak, *Casuarina distyla*; Sandal-wood, *Santalum lanceolatum*, and mulga, *Acacia aneura*, grow on the open flats, and the native pine, *Callitris glauca*, on the ranges. Native peach trees (quandong), *Santalum acuminatum*, whose fruit was much favoured by the aboriginals, are occasionally seen on both the plains and the sides of the stony hills. Salt-bush, *Atriplex vesicarium*, and blue-bush, *Kochia sedifolia*, cover the undulating countryside, and tussocks of *Triodia* the higher hills and ranges. In the early days of white settlement this grass was known as "porcupine" because of its needle-like spines—hence the name, Porcupine Range. Spear-, and other native grasses flourish on the open flat country after the erratic rains.

Kangaroo, euros, emus, echidnas, lizards, snakes, goannas and many sorts of birds frequent Pitcairn station, but wombats, wallabies and dingoes, once present in considerable numbers, have become almost extinct since the Sawers family acquired the sheep station in 1895. It will be seen from this that there would have been an adequate supply of food to support an aboriginal population in recent and probably also in prehistoric times.

ROCK ENGRAVING SITES

The rock engravings on Pitcairn and Hill Grange stations have been divided into five groups, *i.e.*, Twelve Mile; Porcupine Range; Mafeking Hills; Manunda Springs and Hill Grange station (map, fig. 1). The first three of these groups are somewhat isolated from the others, while the latter two are situated on the continuous line of hills extending from Manunda Springs, across Hill Grange station, into the adjoining property. The present survey has been confined to Pitcairn and Hill Grange station; the engravings at other sites located in this north-eastern area are at present being investigated.

Twelve Mile

This site, a rocky outcrop near an out-station, is about twelve miles south-east of Pitcairn station homestead. At the present time the only indication of a water supply is a few minor rockholes near the engravings and possible soaks in the bed of a watercourse some distance away.

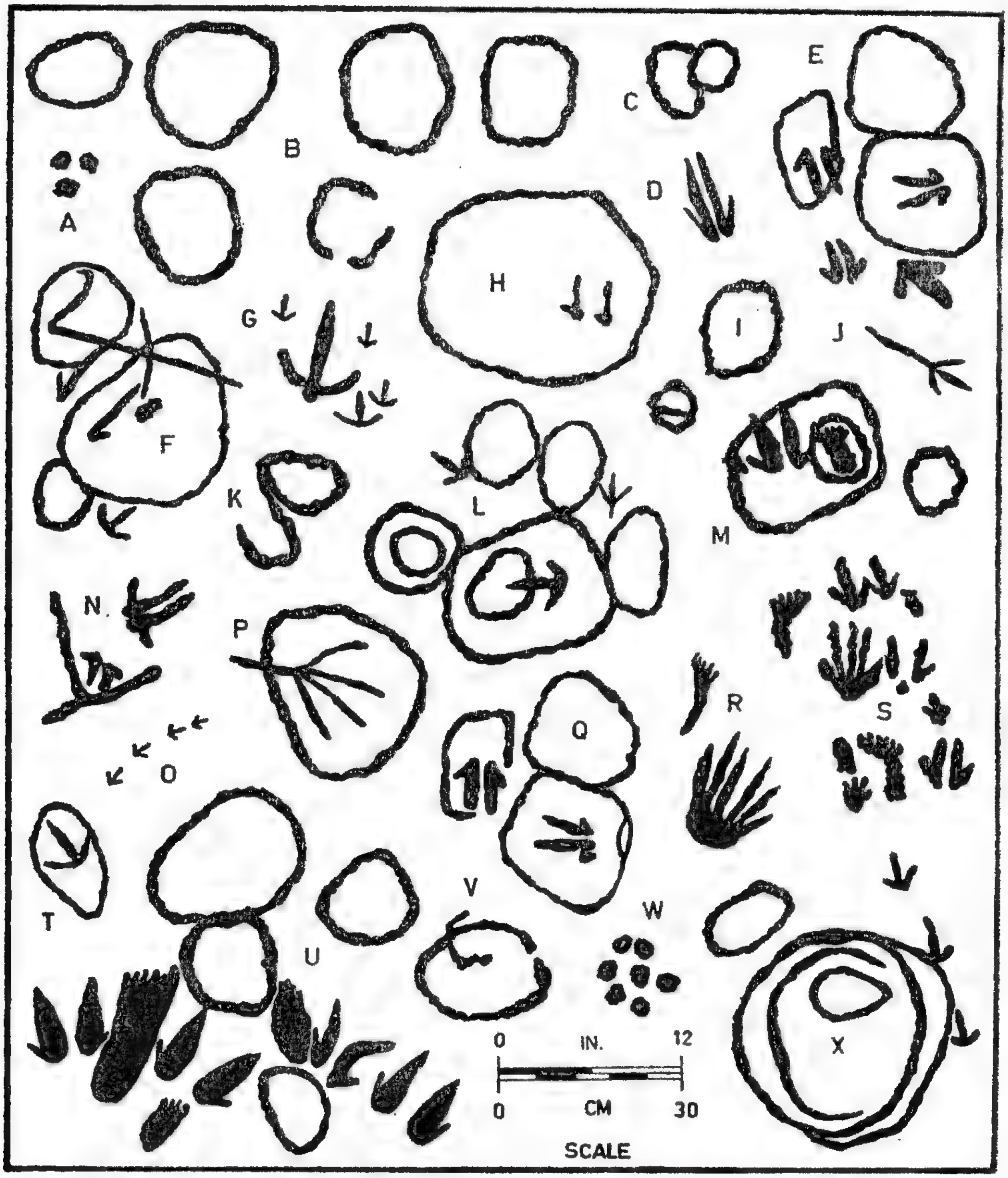

Fig. 2. Rock engraving designs from the Twelve Mile site, Pitcairn station.

The engravings are confined to the smooth surfaces of an uneven outcrop situated at the eastern end of the low line of hills rising out of the broad plain to the west of Levi Range (map, fig. 1). Although the number of engravings is not large, the proportion of apparently unfinished designs is greater than those found among the other groups examined. Many of these engravings at the Twelve Mile are well preserved (plate 44), while others have been almost entirely worn away by erosive action of water and wind-blown sand.

There are few unusual designs at this site. Most depict animal tracks (fig. 2D, E, N, Q. X) and circles (fig. 2B, C, E, F, H, I, L, M, P, Q, T, U, V and X), all of them characteristic of South Australian rock engravings. The tracks include those of an adult emu with chicks (fig. 2G). There are a number of human foot and handprints with peculiar outlines (fig. 2M, R, S, U,), the feet having four, five or six toes, and the hands four to six fingers.

Porcupine Range

A semi-permanent spring is located in a secluded, steep-sided gully on the northern slopes of Waite Hill (map, fig. 1). As it flows towards the open plain the water from this spring fills many rockholes (plate 43, fig. C). Evidence of aboriginal visits to this isolated valley is indicated by the designs engraved on rock surfaces adjacent to the water supplies.

The most unusual and extensive group is an intricate collection of circles and tracks on one large pavement near a creek (fig. 6). Other designs (many badly weathered), include crescents (fig. 4E, F, K, L, R), a number of small engraved disc-like designs (fig. 4P), emu tracks (fig. 4H, J, M, S) and some human footprints (fig. 4G, O, Q). Several of the engravings of emu tracks (fig. 4J, S) may have been intentionally distorted. Mountford (personal communication) states that the aboriginals of the Wailbri tribe of Central Australia, depict the tracks of a mythical lame emu, *kalaia,* in a similar manner.

Mafeking Hills

Near some small rockholes among these hills, a few portions of engraved circles and tracks were found. There may have been other engravings at this site at some time, but the surface of the rocks has been broken into so many fragments that any other designs would have been obliterated.

Manunda Springs and Hill Grange Station

The aboriginals engraved many designs on the outcropping rocks in the line of hills (plate 45, fig. A) which extends in a general north-easterly direction from Manunda Springs across Pitcairn to the Hill Grange station (map, fig. 1).

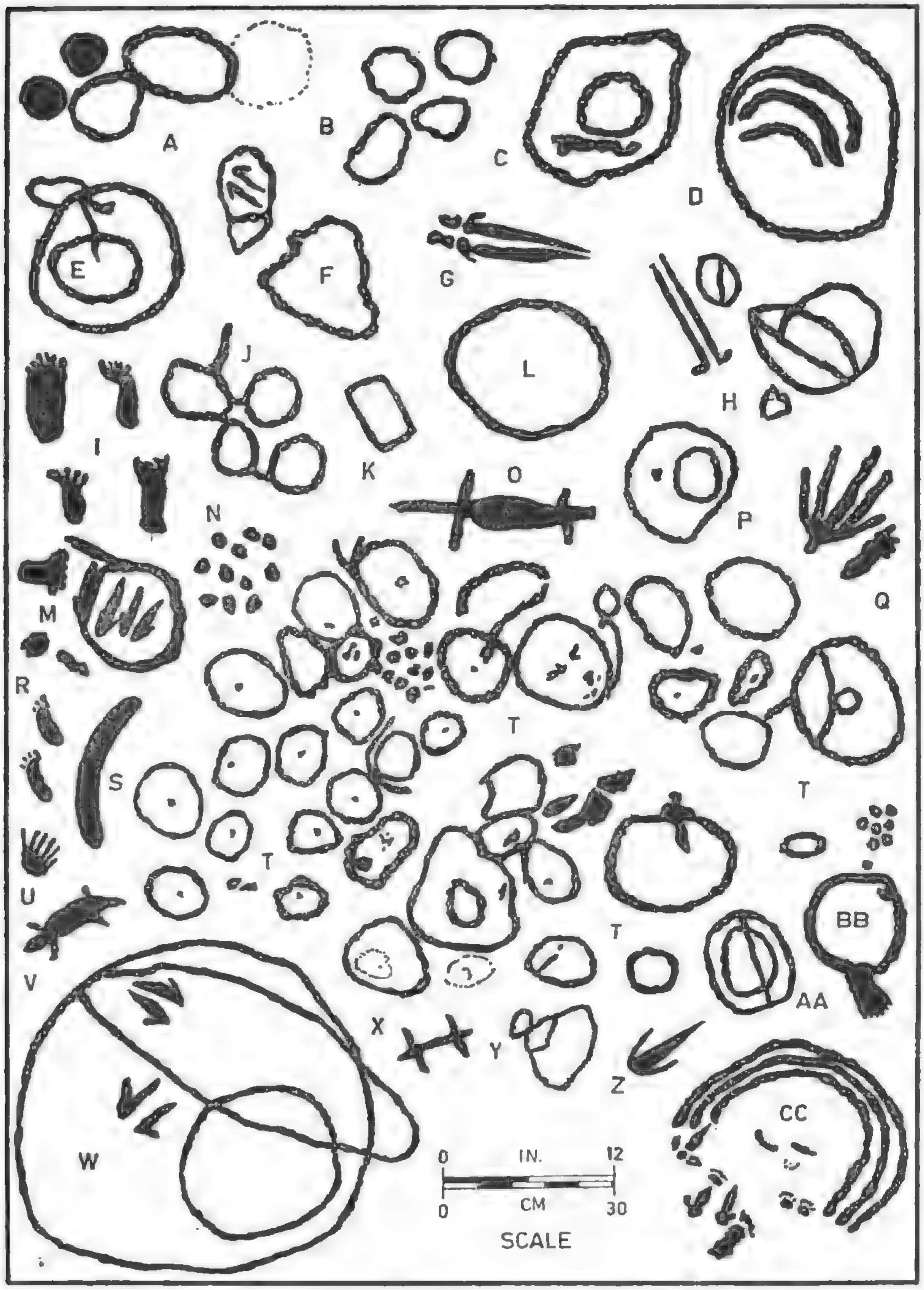

Fig. 3. Rock engraving designs from Hill Grange station.

Although there are a number of simple engravings at the Manunda Springs (fig. 4A, B, C, D), the designs are more numerous and complex near the Hill Grange boundary (plate 45, fig. B). Here are many circular designs (fig. 3A, B, C, D, E, F, J, L, P, T, W, AA, BB) and several examples of the barred circle (fig. 3H, AA). Fully intagliated lizard designs (fig. 3O, V), common in the Panaramitee area (Mountford and Edwards, 1963), are rare at this locality. As at the Twelve Mile site, animal tracks form a large proportion of the engravings. There are poorly executed human footprints (fig. 3I, M, Q, R, BB, CC), several small marsupial tracks with large crescents (fig. 3CC) and a few disc-like designs (fig. 3N, BB).

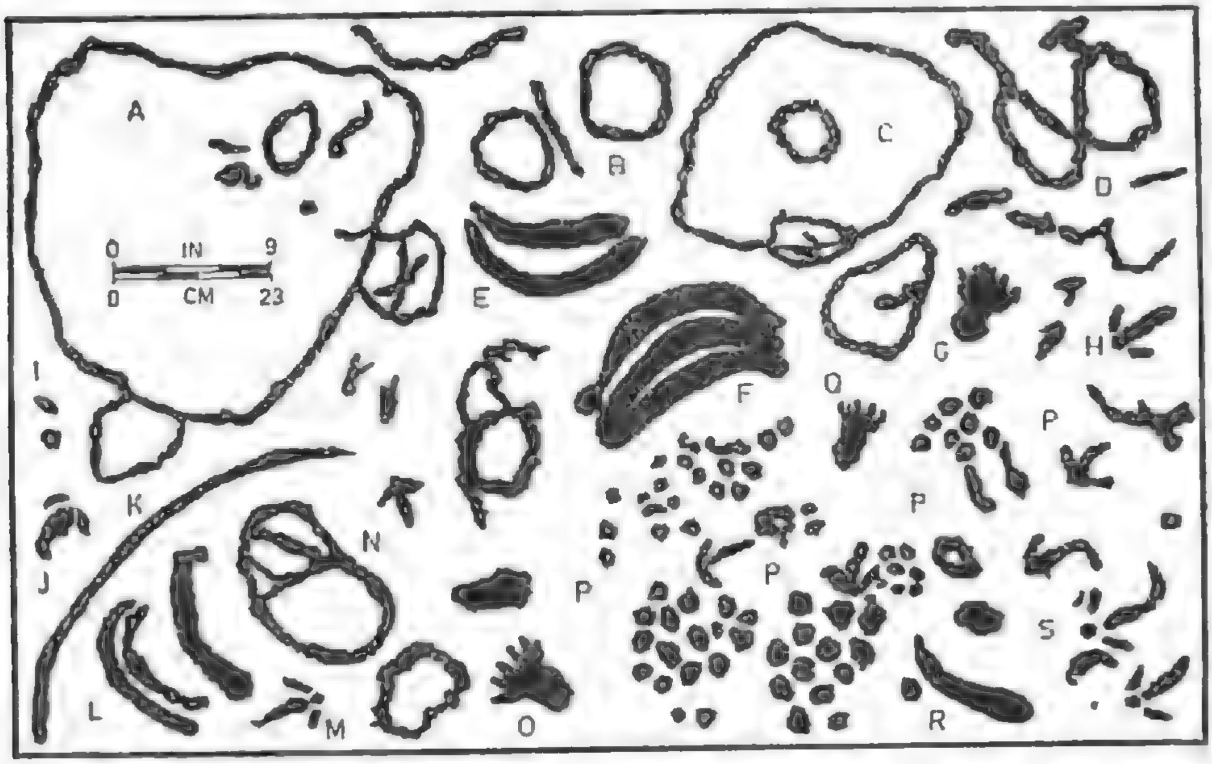

Fig. 4. Rock engraving designs from Manunda Springs and Porcupine Range.

During the examination of some rock engravings on the slopes of a hillside on Hill Grange station, a group of partly covered circles was noticed in the bed of a shallow gutter. The removal of soil and rubble to a depth from six to twelve inches revealed more engravings (fig. 5, plate 43, fig. B). Other buried rock faces probably exist, but as the deposition of the debris took place at irregular intervals of time, such detrital cover is not likely to supply evidence of age, but serve merely to protect the engravings from weathering and erosion. Similar occurrences of buried engravings have been recorded from sites in the Northern Flinders Ranges by Hale and Tindale (1925), in Deep Creek, near Burra, by Campbell (1925) and Biddle (1925), and from Panaramitee North, by Mountford and Edwards (1963), and stated as being adjacent to, or in, creek beds, partly covered by a layer of soil.

TECHNIQUES

There is no published record of any white person having witnessed an aboriginal making an actual rock engraving in South Australia, and the tools are unknown. Basedow (1914, 1925), Hosking (1926), Mountford (1935) and Mountford and Edwards (1963) have suggested that rock engravings were produced with a sharp-pointed piece of hard stone, either hand-held or used as a chisel-like instrument.

Experiments on typical rock face material have shown it is possible to produce suitable pits by both methods. The use of a hammer-stone and chisel however enables a more controlled application of the force to the rock surface; as many of the designs were engraved with fine detail and accurately and sharply portrayed, some carefully directed use of the tools employed would have been necessary. The measure of exactness and regularity seen in many of the engravings (plate 44, fig. C) would have been difficult to achieve with a single hand-held implement. A search in the vicinity of rock engravings for specialized tools has been undertaken without success by a number of investigators, Basedow (1914, 1925); Stapleton (1931) and Mountford and Edwards (1963). As quartzite and the milky variety of quartz are the hardest materials available and occur in abundance near all the rock engravings, some fragments of these may have been used in one of the methods adopted. If struck with the correct amount of force and at a suitable angle, selected pieces of these materials have sufficient hardness and toughness to penetrate the softer rock surface a number of times without damaging the point. There are instances where variations in the size and shape of the individual punch marks can be seen, suggesting a difference in tool point and in the action of striking the rock surface to produce an engraving. Several of these variations are seen in plate 44, fig. C, D. Heavy blows from an implement of some weight would have been required to make the large circular pits which comprise the design on plate 44, fig. A. The detailed study being undertaken of the various kinds of depressions forming the designs of the engravings may help to provide evidence of the techniques employed.

Only a few examples of straight line markings (plate 44, fig. B) were found similar to those recorded from other sites by Basedow (1914); Tindale and Mountford (1926); and Mountford (1929).

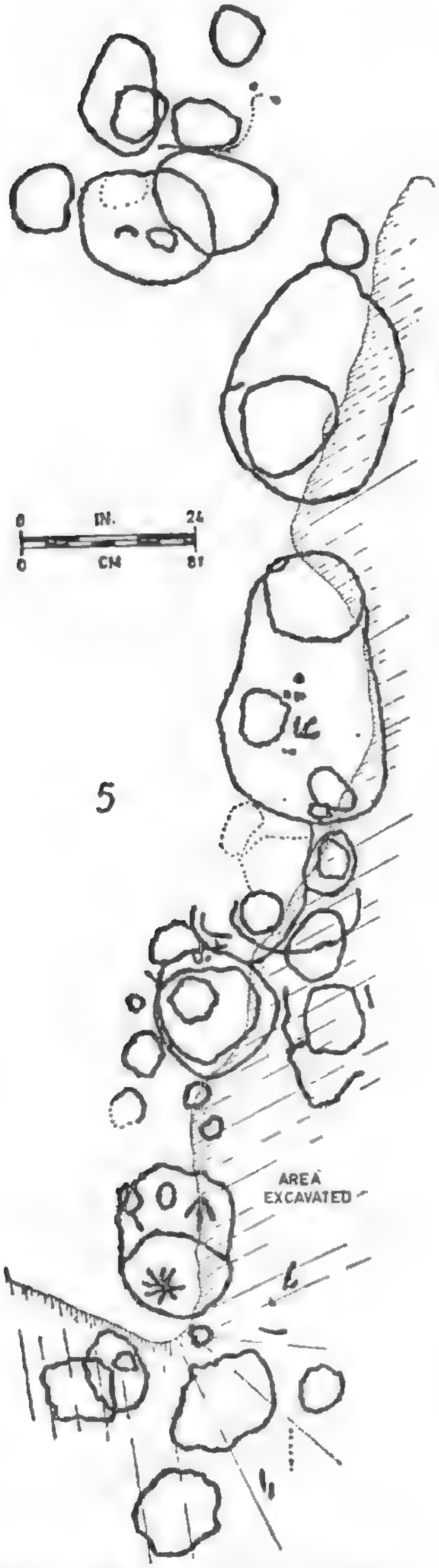

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Fig. 5. Rock engravings revealed by excavation on Hill Grange station.
Fig. 6. Extensively engraved rock pavement in the Porcupine Range, Pitcairn station.

WEATHERING

Most of the sites so far examined have presented instances of engraved surfaces in an advanced state of deterioration due to the effects of long weathering. As there is insufficient evidence to determine the rates of this weathering process it cannot be used as a reliable basis for estimating age.

The engravings on outcropping rock surfaces situated on Hill Grange station provide striking evidence of the effects of weathering and disintegration. Chemical and mechanical weathering, aided by erosion by water and wind, appear to be the principal factors causing fragmentation of the rocks in this region. In some places only small portions of the designs remain while there are instances where practically the whole surface has been broken into fragments and many of them washed down the hillside. For example, a large group of circles (fig. 3T, T; plate 45, fig. B) has been so affected that some of them have obviously disappeared and nearby slabs of the engraved, outer layer of the rock have become detached and rest loosely on the underlying mass.

ANTIQUITY

Many of the authors who have recorded rock engravings in South Australia have speculated on their age (Basedow, 1914, 1925; Campbell, 1925; Biddle, 1925; Hale and Tindale, 1925, 1929; Hale, 1926; Tindale and Mountford, 1926; Mountford, 1929, 1935, 1960; Stapleton, 1931; Tindale, 1935; Cooper, 1941; Mountford and Edwards, 1962, 1963). The general opinion is that they are of some antiquity. This suggestion is based on the weathered condition of the rock surfaces, evidence of minor earth movements, patination, the presence of engravings of both extinct creatures and their tracks, and the fact that living aboriginals of the Flinders Ranges and other areas where such engravings exist have asserted that they are not the work of their people, but of mythical ancestors who lived during creation times.

The engravings have been cut into the hardened and heavily patinated surface layers of the local rock masses. Such rock alterations probably involve a long period of time. It is therefore important to determine, if possible, to what extent patination of the rock surface has occurred subsequent to the engraving of the designs. The strongest evidence of age must rest upon the extent of deterioration of engraved markings or their patination. While some have the appearance of marked "ageing", others present a sharpness in the cut margin suggesting a later origin.

Mountford and Edwards (1962) recorded their observation of the apparent absence of dingo tracks among the large number of engraved animal and bird tracks recorded in the north-east of South Australia. This may imply that some of these engravings predate the arrival of the native dog on this continent. No representations of dingo tracks were found among the engravings examined in the Pitcairn area. It is of interest that dingo bones were recovered in a recent archaeological excavation at Fromm Landing, South Australia, by Mulvaney, Lawton and Twidale (1964). Carbon 14 tests have dated the levels of these remains at between 1000 ± 91 B.C. and 1220 ± 94 B.C. and to be the oldest dated dingo remains recorded for Australia.

The engravings examined during this survey are comparable with others so far recorded from adjacent regions. There is a resemblance in the detail of the designs; weathering has advanced to a like degree and the same techniques appear to have been employed. It is therefore reasonable to suggest that the whole series (map, fig. 9) are the work of related groups of aboriginals, and may be contemporary.

While searching for rock engravings in the Pitcairn area, many rounded piles of fire-burnt stones (plate 43, fig. D) were observed along the Manunda and other watercourses (map, fig. 1). Gray (1930) at Orroroo and Meyer (1846) at Encounter Bay note the use of heated stones for cooking by the aboriginals, and it is likely that the blackened stones located indicate fireplaces. During the survey of Panaramitee station in 1961 (Mountford and Edwards, 1963) similar hearths were noticed along the Yunta and Winnininnie Creeks and their tributaries. Such watercourses, supplemented by associated permanent springs, would have been sufficient to support both the people who made the neighbouring rock engravings and the game which would have provided them with a food supply. Consequently it appears that the watercourses of this region and the nearby exposed rock surfaces, were the main factors determining the situation of these rock engravings. The map (fig. 9) shows such a distribution in and around the Manunda-Yunta Creek drainage area.

The possibility that the Manunda Creek and its tributaries were once semi-permanent watercourses, flowing towards the Murray as part of the north-eastern drainage system, cannot be discounted if the present aridity of the climate of northern South Australia is of comparatively recent origin, as has sometimes been suggested (Howchin, 1914).

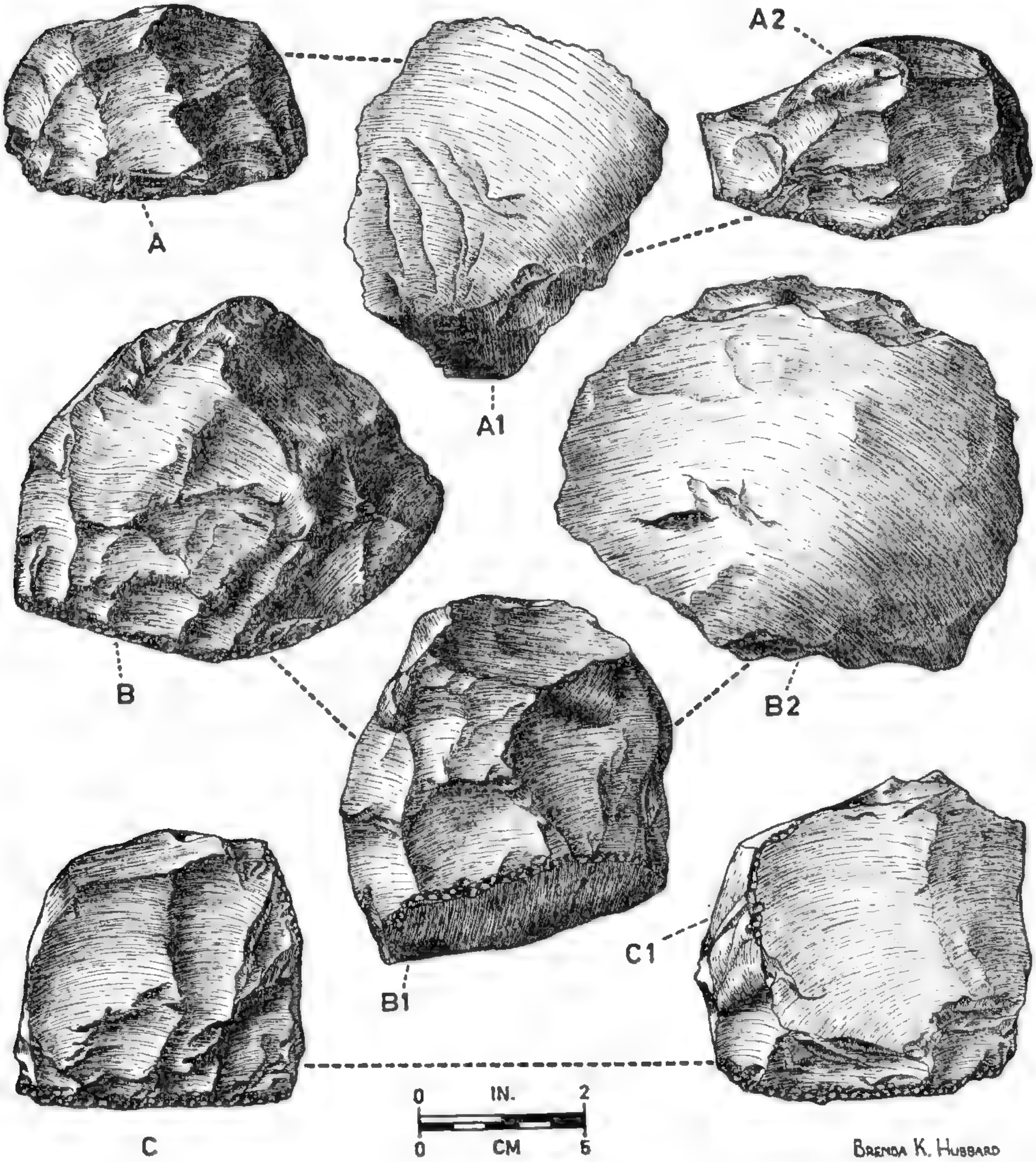

Fig. 7. Large stone implements from the Manunda Creek, camp-site A, Pitcairn station.

A. Large, trimmed flake implement, arapia in form, with a flat base and characteristic working platform. Specimen Reg. No. A54666 in South Australian Museum.

B. Trimmed core implement with a slightly convex or keeled base and secondary trimming around the periphery. A54667.

C. Horsehoof-shaped core implement with two working edges. A54668.

OCCUPATION SITES

In many instances where hearths were observed, the banks of the watercourses are almost devoid of vegetation, apart from occasional clumps of salt-bush and blue-bush. Some of these areas have been undergoing continuous surface erosion by wind and water, leaving a mass of stones strewn about on the bared areas of red clay. In some places, much of the land surface is disintegrating and being carried away in newly forming erosion gutters. Low rainfall and the effects of pastoral activities currently inhibits the growth of a cover of vegetation. Erosion has not only been responsible for exposing hearths and implements—some can be seen embedded in the banks of the watercourses—but it is likely that it has also caused some to have been washed away into the creeks.

The search for stone implements in these areas produced discarded flakes and implements of varying sizes. At three particular localities (map, fig. 1 A-B; C and D) the number of implements collected was sufficient to indicate more than a casual stopping place.

Manunda Creek (Site A)

This camp-site is located on a well-drained position on the high western bank of the Manunda Creek (map, fig. 1A). The now temporary spring at the base of some slate outcrops in the creek bed may account for the presence of the nearby camp-site. Here erosion has removed the more friable surface soil leaving an assemblage of stones, including many implements, discarded flakes and fire-hearths. The collection of artifacts made from this site consists of 231 large implements, mainly trimmed cores (*e.g.*, fig. 7) made from coarse grained quartzite readily available in the bed of the Manunda Creek; 90 smaller flakes of irregular shape with varying amounts of trimming; 18 worked cores; two geometric microliths; two microlithic end scrapers made from australites; 114 discarded quartzite flakes and 63 scraps of milky quartz and chalcedonic material.

Manunda Creek (Site B)

Some eroded clay flats, a little to the north, form an extension of the main Manunda site (map, fig. 1B). Here fireplaces were located and a few large implements and untrimmed stone flakes collected.

Manunda Creek (Site C)

This camp-site is on the banks of the Manunda Creek about a mile up-stream from the main site (Site A). Only a small number of implements were found, but an interesting feature was some well-defined areas strewn with great quantities of milky quartz fragments, apparently broken up during the manufacture of implements from this material.

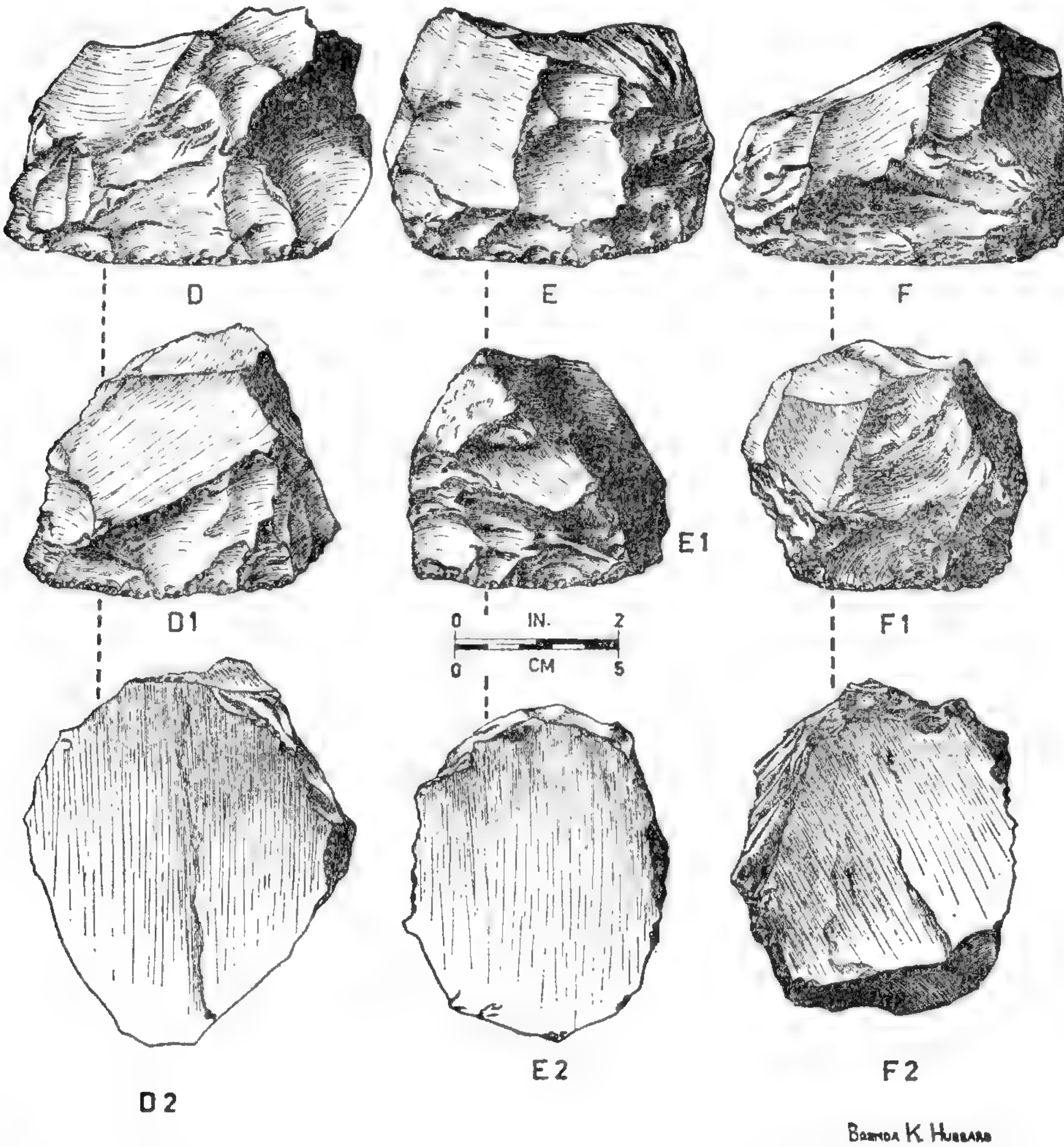

Fig. 8. Large trimmed core implements from Albert Hill, camp site D, Pitcairn station.

D. Core chopping implement showing the functional edge sharp and intact. A54669.

E. Core chopping implement with functional edge re-worked or sharpened as a result of continued use. A54670.

F. Core chopping implement re-worked to such an extent that the implement is almost worn out and of little further use. A54671.

Twenty-eight artifacts were recovered, including 14 semi-discoidal adze-stones of milky quartz; 24 indefinitely shaped flakes of the same material (all bearing evidence of secondary trimming), three geometric and one semi-discoidal microliths.

Albert Hill (Site D)

This rather isolated camping ground, covering some 50 acres of the banks and adjoining flats of a Manunda Creek tributary, is midway between the Pitcairn homestead and the Twelve Mile rock engravings (map, fig. 1D).

The variety in the implement types collected differ from those of the main Manunda Creek camp-site (Site A). Thirty-eight large core implements were recovered; microliths comprised 15 geometrics, one discoid and three semi-discoids, one nosed scraper, seven end-scrapers and some small worked cores. There were approximately 800 scrap flakes; six of these show trimming. Some of the large implements are good examples of their respective types, three in particular (fig. 8) clearly exhibit the stages of modification of the shape of a core implement when it was continuously re-sharpened.

DISCUSSION

There is no conclusive evidence to indicate the density or permanence of the prehistoric population of the Pitcairn region. The number of artifacts found is small when compared with the quantity recovered from other parts of northern South Australia (Mitchell, 1949; Cooper, 1954). This suggests that this particular area was not permanently occupied by a large community at any period.

The predominance of large implements among the material collected on the Manunda Creek indicates a similarity to the *Kartan* camp-sites recorded at Hallett Cove (Cooper, 1959), near the River Wakefield (Cooper, 1961), and to a limited extent on Kangaroo Island (Tindale and Maegraith, 1931; Cooper, 1960) where the proportion of such implements was also high in comparison with smaller types. Other massive implements were retrieved by Cooper (1943) from camp-sites near the rock engravings at Mount Chambers Creek, Oratunga and on Boorloo Creek near Marree (Cooper 1941). Most of the implements from all these sites are similar in size, form, material and technique of manufacture.

Assuming these are Kartan implements and are ancient, as has been suggested, they may belong to the same period as the rock engravings. If so they provide further indications of the possible antiquity of the engravings.

Many of the trimmed core implements recovered from the Pitcairn area bear evidence of constant use, some having been sharpened a number of times by trimming the functional margin with blows by a hammer-stone (figs. 7 and 8). The edges of some tools have been re-worked in this manner so often, that further sharpening would have been impossible and they were obviously discarded. Cooper (1961) states that the high proportion of core chopping implements found along the banks of the River Wakefield—also worn to the limits of their usefulness—may represent an accumulation of tools discarded over an extended period by a relatively small population. This may also be the explanation for the findings of the Pitcairn area.

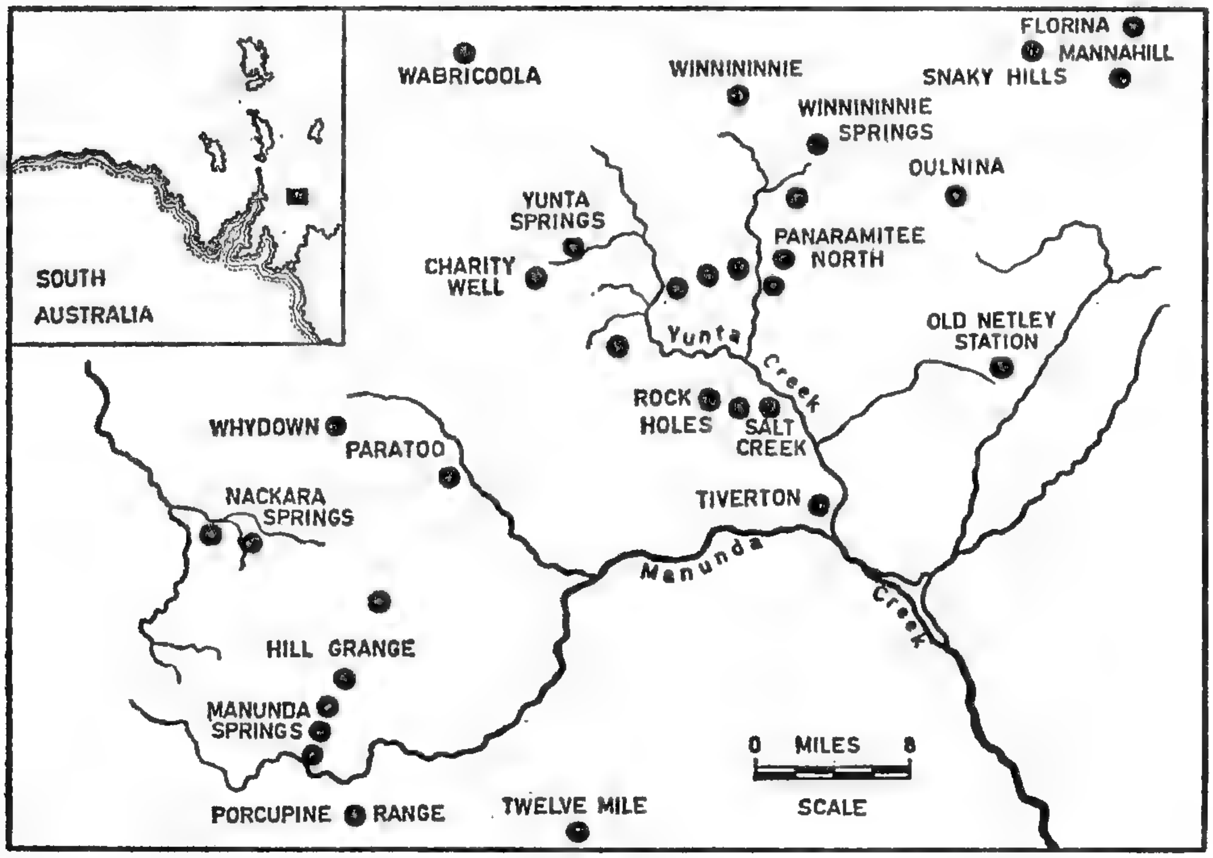

Fig. 9. Map showing the general distribution of known rock engraving sites in or near the Manunda-Yunta Creek drainage area.

Certain rock painting sites in Central Australia are situated well away from regular camping places and forbidden to all but the fully initiated. In contrast to this, the groups of rock engravings in the north-east of South Australia occur in places where good water and food supplies were available and therefore may have been near regular, general occupation sites. If so, the engravings may not have had any particular restricted sacred or ceremonial significance but rather represent the efforts of the aboriginal inhabitants of the long past, reminding themselves of their mythical and legendary stories in both naturalistic and abstract styles. Interpretation of such a vast array of stylized figures is not an easy matter. Certain of these, such as simple or concentric circles, wavy lines and crescents, are not uncommon among designs executed by living aborigines and may thus be decipherable. But in addition there are many other designs and patterns which could probably be designated as expressions of abstract aboriginal art. Further discussion of this aspect is beyond the scope of the present paper, the purpose of which is to record the available information about the rock engravings and stone artifacts of the Pitcairn and Hill Grange stations.

ACKNOWLEDGMENTS

The author acknowledges the interest and enthusiasm of Mr. Brian K. Sawers and his family who provided accommodation, supplied transport for field work and generally assisted in the collection of implements and tracing of engravings. Without their generous help it would have been impossible to carry out the survey. Mr. S. R. C. Lang of Hill Grange station kindly gave permission to continue the survey on his property. The encouragement and advice of Mr. C. P. Mountford, Professor G. H. Lawton and Drs. T. D. Campbell and P. S. Hossfeld during the preparation of this paper is appreciated. Mr. H. M. Cooper gave assistance in comparing the various implements from Pitcairn with those he has collected, and his advice was invaluable in other ways.

The Board for Anthropological Research of the University of Adelaide granted funds towards the expenses of field work of this research. Mr. M. R. Marchant, of the South Australian Lands Department, provided details needed for the preparation of maps. The plates, figures and maps have been prepared by the author, and the outlines of implements drawn by Miss Brenda Hubbard. Acknowledgment is also made to the Board of the South Australian Museum for publication of this paper and to Mr. Norman B. Tindale, Curator of Anthropology, for his consideration and advice. The figured specimens have been placed in the South Australian Museum collection.

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EXPLANATION OF PLATES

PLATE 43

Fig. A. Hill Grange station looking south with the Porcupine Range in the background.
Fig. B. Rock engravings revealed by excavation on Hill Grange station.
Fig. C. Semi-permanent spring situated in the Porcupine Range, Pitcairn station.
Fig. D. Fire blackened pile of stones on the Manunda Creek camp-site, Pitcairn station.

PLATE 44

EXAMPLES OF ROCK ENGRAVINGS, TWELVE MILE SITE, PITCAIRN STATION

Fig. A. A circular design composed of rounded pits.
Fig. B. Straight line markings.
Fig. C. An unfinished emu track with variations in size of the peck marks.
Fig. D. Typical South Australian rock engravings.

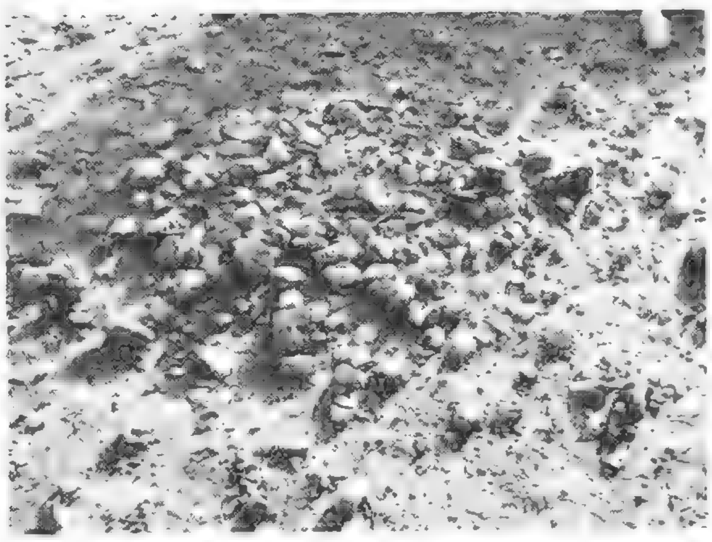
PLATE 45

Fig. A. Hill Grange station, looking north.
Fig. B. A weathering, engraved rock surface, Hill Grange station.

A

B

C



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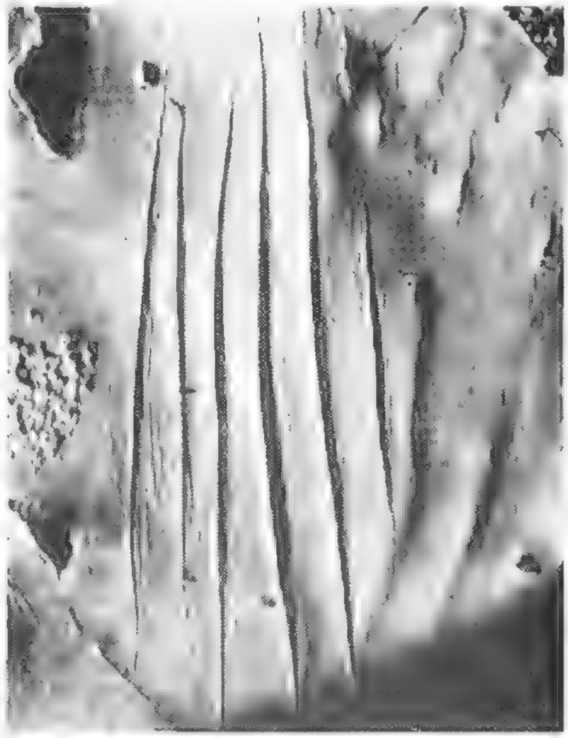
A



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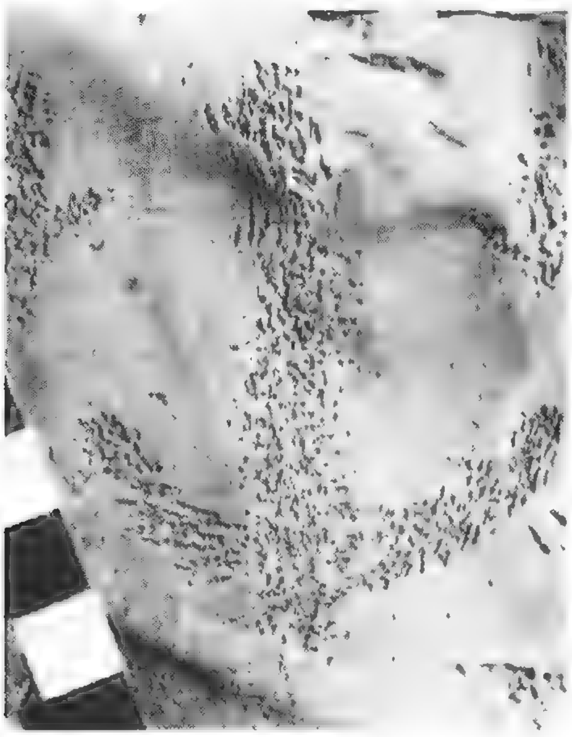

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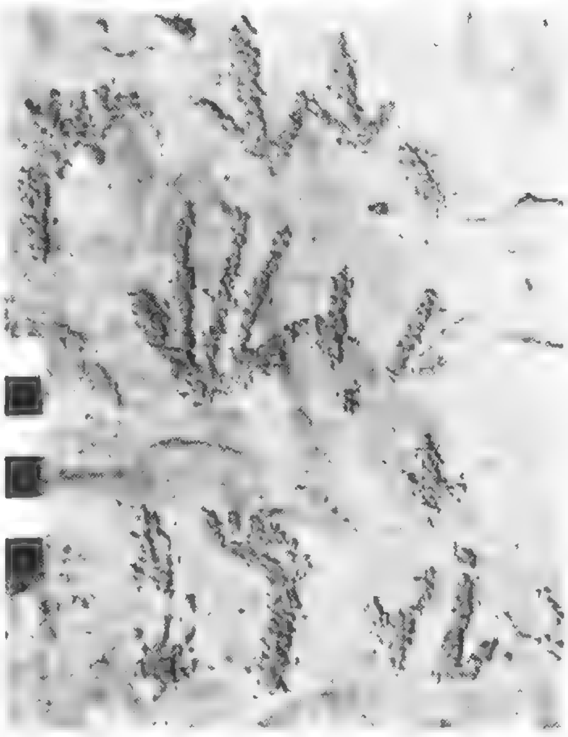

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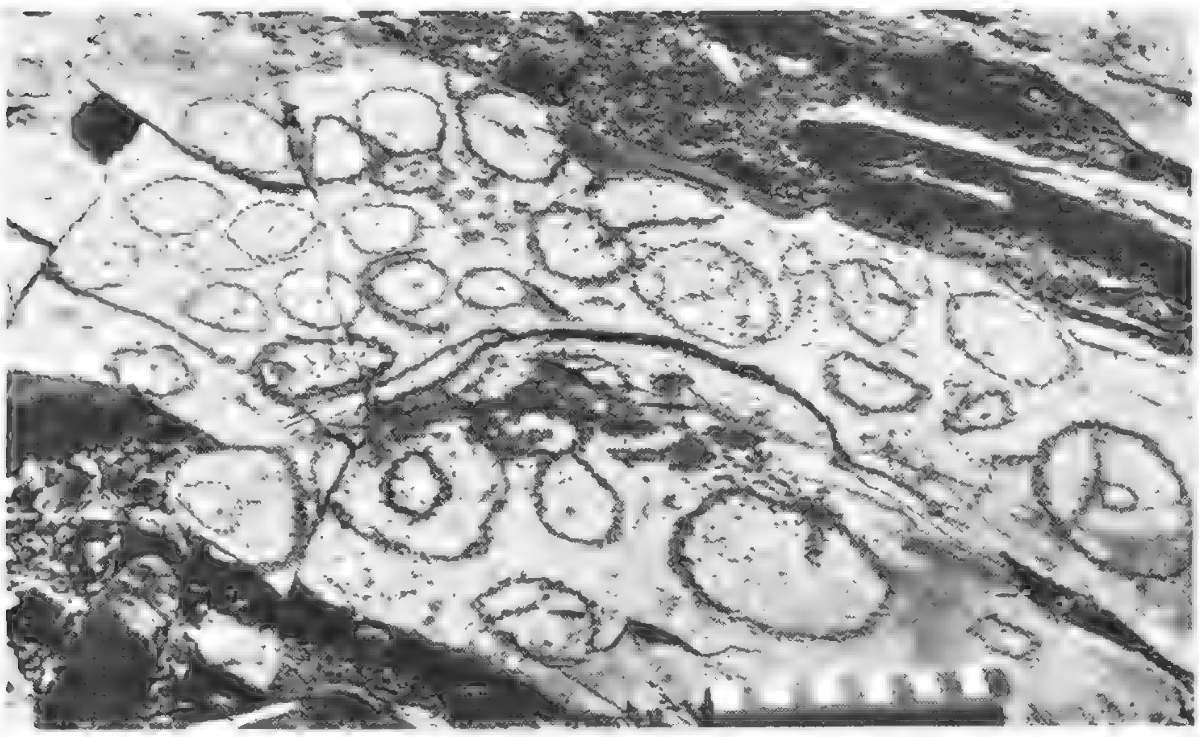

REVISION OF THE GHOST MOTHS (LEPIDOPTERA HOMONEURA, FAMILY HEPIALIDAE)[1]

PART VIII

BY NORMAN B. TINDALE, SOUTH AUSTRALIAN MUSEUM

Summary

Two new species of Oxycanus are described, O. buluwandji Tindale from Lake Barrine, Queensland and O. hildae Tindale from the Victorian Alps. The hitherto unknown female of Trictena argyrosticha Turner is reported from Stanthorpe, Queensland, and some observations are given on other species of Oxycanus.

REVISION OF THE GHOST MOTHS (LEPIDOPTERA HOMONEURA, FAMILY HEPIALIDAE)[1]

PART VIII

By NORMAN B. TINDALE, South Australian Museum

Plates 46-47

SUMMARY

Two new species of *Oxycanus* are described, *O. buluwandji* Tindale from Lake Barrine, Queensland and *O. hildae* Tindale from the Victorian Alps. The hitherto unknown female of *Trictena argyrosticha* Turner is reported from Stanthorpe, Queensland, and some observations are given on other species of *Oxycanus*.

INTRODUCTION

The present paper describes several new or noteworthy Australian species belonging to two genera, *Oxycanus* and *Trictena* which have been dealt with in earlier pages of this Revision.

I am indebted again to Mr. C. G. L. Gooding for opportunities to see some material discussed herein; he has again been good enough to deposit types in the South Australian Museum collection.

Oxycanus buluwandji sp. nov.

Plate 46, fig. 1

Male. Antennae brown, pectinations rather long, slender, 2, tapering rather suddenly to tip, each pectination with an apical tuft of ciliae; head and thorax ochreous with a greyish-green tinge, abdomen at base brightly ochreous, becoming duller and greenish-tinged towards apex. Forewings warm brown with bright ochreous patches which tend to be concentrated in a zig-zag from the termen near forewing tip to inner margin at one-half, then extending towards base; a series of small, paired golden yellow spots each ringed with brown tending to run in lines across the wing, generally parallel to termen, with a rather greater number concentrated in a subterminal area where the linear arrangement is rather disturbed; there is also a subterminal series of semi-lunate brown spots between each of the veins from the apex to

(1) Part VII of this series was published in these Records, Vol. XIII, pp. 157-197.

the inner margin. Hindwings ochreous at base, dark brown on distal half; in life the base of the wings may have had a fugitive pink tinge. Wings beneath ochreous with the outer margins darker.

Forewing length 54 mm., expanse 121 mm.

Loc. Queensland: Lake Barrine, 1928, E. J. D. (type, a male, unique, I.19112 in S.A. Museum).

This is a large and outstanding member of that group of Australian species within the genus *Oxycanus* which centre around *O. beltistus*. In these the male genitalia, when obliquely viewed, are seen to possess a series of spines of equal length along the latus of the tegumen. This is the seventh species which falls into the group. In general appearance it is closest to *O. beltistus* Turner particularly in the rather broadly pointed forewings, showing a suggestion of subfalcation; in markings it seems to be most like *O. naias* Tindale, but that species has well rounded fore wing tips.

Except for the rather aberrant *O. aedesimus* (Turner) from the Eungella Plateau, Queensland, this is the first species of the genus to be taken at a point intermediate between the mountains of New Guinea and the Brisbane district of Queensland. In life it must be a very striking insect.

When compared with New Guinea species *O. buluwandji* probably falls nearest to *O. tamsi* Tindale, from Mount Goliath, in the form of the genitalia and in the suggestion of subfalcation of the forewings, but the peculiar shape of the hindwings of *O. tamsi*, the different, shorter antennae, and the distinctive markings set the two apart; *O. tamsi* is much the smaller of the two species.

The name chosen is based on the tribal name of the negrito people who claim Lake Barrine as their territory. Mr. C. G. L. Gooding, in whose collection I noticed the specimen, has kindly passed the type to me for preservation in the South Australian Museum collection.

Oxycanus rosaceus Tindale

Oxycanus rosaceus Tindale, 1935, Rec. S. Austr. Mus., Adelaide, 5: 306, fig. 33, 82-83.

The only known Victorian specimens of this interesting species were those taken in various years by Mr. C. G. L. Gooding near Moe, Victoria, the last occasion being on 24 April 1944. The restricted area where they occurred was cleared of vegetation and ploughed up immediately after the 1944 emergences and no further specimens have been noted in the district. In Mr. Gooding's opinion the larvae are external root feeders on a species of *Eucalyptus*.

Oxycanus diremptus (Walker)

Plate 47, fig. 1

Porina dirempta Walker 1865, List. Lep. Ins. Brit. Mus., 32: 597.
Oxycanus diremptus Tindale 1935, Rec. S. Austr. Mus., Adelaide, 5: 289.

Most of the species of the genus *Oxycanus* tend to be variable in wing markings, with a wide range from melanic forms through well-marked, often silvery-spotted and banded forms to rather highly decorative paler forms in which flashes of ochreous and white are present. *O. diremptus* is no exception in being variable as to markings, although forms possessing an abundance of silvery white are unusual. The striking example figured (plate 47, fig. 1) was taken by Mrs. Margaret Coulson at Moe, Victoria, on 21 April 1951, and is in the collection of Mr. C. G. L. Gooding.

The specimen has a forewing length of 38 mm. and expanse of 88 mm., being a rather large male specimen but falling within the normal limits of variation in size, of the species.

The forewing has the costa narrowly chocolate-brown and the terminal area is a somewhat lighter shade of the same colour. The discoidal markings are ochreous, narrowly margined with brown, as are also the more obscure markings between the greatly expanded area of silvery-white which occupies the greater part of the forewing; the anal area is mottled with fine gray scales and hairs. The hindwings and the underside of wings are as in more normal specimens of the species. The genitalia in no way differ from the more normal members of the species. The character of the latus of tegumen clearly indicates its specific identity with *O. diremptus*. In wing pattern it probably is the extreme development of that form of the species which has been named *O. diremptus* form *kershawi* (Lucas).

In a former paper in these Records (11, 1955, pl. 32 f. 8) I depicted one of three specimens of a similar silvery extreme form of the species *Oxycanus sordidus* (Herrich-Schaeffer) taken at Red Hill, Victoria.

Oxycanus hildae sp. nov.

Plate 46, fig. 2-3

Male. Antennae yellowish-ochreous, slender, pectinations 2. Head and thorax pale brown, abdomen pale ochreous fawn, a little darker towards apex. Forewings subhyaline, pale brown with rather obscure markings in pale fawn, indistinctly margined with brown; veins and margins of wings appear darker and contrast with the yellowish-ochreous of ciliae; base of wings posteriorly clothed in ochreous yellow hairs. Hindwings subhyaline, pale brown with the veins margined with pale ochreous yellow, ciliae also ochreous yellow; base of wings clothed in ochreous yellow hairs. Wings beneath dusky brown, darker along the veins with termen and portions of veins of hindwings tinged ochreous.

Forewing length 29 mm., expanse 63 mm.

Female. Antennae yellowish-ochreous, slender, scarcely pectinate. Head and thorax pale brown, abdomen pale ochreous fawn. Forewings subhyaline, pale ochreous fawn with brown markings, some of which show vague traces of a paler centre, veins emphasized by yellow scales, sometimes bearing patches of darker scales, ciliae ochreous. Hindwings subhyaline with traces of same markings as in forewing, veins strongly margined in yellow, margins and ciliae brightly ochreous; base of wings with ochreous yellow hairs. Wings beneath dusky brown, veins emphasized with ochreous towards termen and margins and ciliae brightly ochreous yellow.

Forewing length 38 mm., expanse 84 mm.

Loc. Victoria: Jacob Creek (holotype male and allotype female 25 April 1946, collected by C. G. L. Gooding) I.19113 in S.A. Museum; also one specimen from New South Wales: Cathcart (paratype, I.19114, male, 11 March 1958, collected by N. B. Tindale).

It is with pleasure that this species is named as *O. hildae* after Mrs. C. G. L. Gooding who shares with Mr. Gooding such enthusiasm for the discovery of new and interesting Lepidoptera.

This species, by reason of the possession of a simple arcuate latus of the tegumen, keys to the vicinity of *O. perditus* Tindale found in Western Australia. The wing markings of the male are somewhat similar to those of *O. perditus* but the species differs in being smaller, less opaquely clothed in scales and in having the evanescently pink hairs (which fade in preserved specimens to an ochreous yellow) confined to the bases of the wings.

The paratype male is slightly smaller (expanse 60 mm.) and the markings tend to be somewhat more obscure but it is evidently the same species. The last named example was taken in a mercury vapour lamp light trap on a night when the 11 p.m. temperature was 53°F.

Trictena argyrosticha Turner

Plate 47, fig. 2

The female of *T. argyrosticha* has not previously been described or figured. I am indebted to Mr. C. G. L. Gooding for an opportunity to record a very fine example taken by Miss Jean Harslett in April 1949 at Stanthorpe, Queensland.

Female. Antennae ochreous, slender and incipiently tripectinate. Head, thorax, abdomen and legs pale brown. Forewings brown, costa ochreous-tinged towards apex, wing covered with scroll-like markings; a well defined oblique white fascia from apex to M_3 at $\frac{3}{5}$ths, bordered with dark brown; traces of a discoidal fascia reduced to a single patch of white scales, a dark brown blotch and some ochreous-tinged scroll-like lines in the position of the silvery-white fascia of males. Hindwings pale brown with the costa narrowly ochreous-tinged.

Forewing length 75 mm., expanse 160 mm.

Loc. Stanthorpe, Queensland (allotype female I.19115 in South Australian Museum).

Like the male, the female of this species differs in well marked fashion from females of the only other known species of the genus, *Trictena argentata* (Herrich-Schaeffer). The key based on male specimens given in a former description (Tindale, Rec. S. Austr. Mus., Adelaide, 4: 1932, 500) will serve, save that the sub-terminal white band, although it tends to be continuous, as in the male, is rather wider than the key indicates as usual in the male.

EXPLANATION OF PLATES

PLATE 46

Fig. 1 Above. *Oxycanus buluwandji* Tindale. Holotype male, Lake Barrine, Queensland.

Fig. 2-3 Below. *Oxycanus hildae* Tindale. Holotype male and allotype female, Jacob Creek, Victoria.

PLATE 47

Fig. 1 Above. *Oxycanus diremptus* (Walker). Unusually marked example, Moe, Victoria, 21st April, 1951.

Fig. 2 Below. *Trictena argyrosticha* Turner. Allotype female, Stanthorpe, Queensland, April, 1949.

To face page 668.]

NOTE ON FLINT IMPLEMENTS FOUND NEAR NIPA, CENTRAL PAPUAN HIGHLANDS

BY H. K. BARTLETT

Summary

In September 1960 I paid a short visit to Nipa on the Nenbi River in the Central Papuan Highlands. (This river is called the Nemb or Nembi by the local people.) The area was described briefly by the late F. E. Williams in the Annual Report of the Territory of Papua for 1938-39. Williams wrote about the Wela valley and its inhabitants as "the grasslanders".

A small landing strip, suitable only for tiny Cessna aircraft, had been cleared in the dense wild sugar cane (pit pit) covered valley. Ninety points of rain in 48 hours were sufficient to close the airstrip.

NOTE ON FLINT IMPLEMENTS FOUND NEAR NIPA, CENTRAL PAPUAN HIGHLANDS

By H. K. BARTLETT

Fig. 1-3

In September 1960 I paid a short visit to Nipa on the Nenbi River in the Central Papuan Highlands. (This river is called the Nemb or Nembi by the local people.) The area was described briefly by the late F. E. Williams in the Annual Report of the Territory of Papua for 1938-39. Williams wrote about the Wela valley and its inhabitants as "the grasslanders".

A small landing strip, suitable only for tiny Cessna aircraft, had been cleared in the dense wild sugar cane (*pit pit*) covered valley. Ninety points of rain in 48 hours were sufficient to close the airstrip.

A Government outpost had been established a few months before my arrival and a Methodist missionary and his family were living in a temporary house near the strip.

The area largely was "uncontrolled", and travel was not permitted for more than a mile and a quarter beyond the Government station.

Flint flakes exposed on the strip attracted my attention. Deep drains had been dug on both sides of the airstrip, and numerous flakes could be seen protruding from the walls of the drains at a depth of three feet. Few of the flints showed signs of secondary chipping. The primary flakes were sharp enough for general use.

When I had gathered a few flakes, small boys were eager to hunt for more. Natives informed me that this flint was known as *are* (or *arer*—see F. E. Williams' Vocabulary of the Augu language).

Taking a sharp flake I pretended to cut my arm. An old man nodded vigorously and pointed to his right hip which was coated generously with pig's fat and dirt. Taking the stance of a bowman he shot two imaginary arrows and indicated that he once had two such arrows in his hip. A small boy spat on his hand and rubbed the spot, removing the dirt, and revealing two scars.

The old man then took two flint pebbles, and using one as a hammer, struck off a sharp flake with which he demonstrated how he had removed the arrow from his flesh.

The Gold lip pearl shell (*Pinctada maxima*) is the greatest treasure of the people. I saw a man engaged delicately in cutting a breast ornament from a large shell. He used a primary flake of *are* to deepen the groove made by long hours of cutting. After three days there was little appreciable difference in the depth of the groove.

Women and girls displayed rows of circular keloids between the breasts, on arms from the shoulders almost to the elbows, on the thighs, and on the calves of their legs. A piece of skin about the size of a sixpence, had been raised to form the keloid. A number of girls came for treatment for infected cuts on the leg. It appeared that this was the last part of their body to be decorated with keloids. A Mendi boy, who acted as interpreter, explained that, before the white men came, women raised keloids by cutting the skin with *are*. Now they use razor blades!

Are appeared to be the material in general use where cutting edges were required. Evidence of its use was seen in some elaborately carved arrows, which, I was told, were shot only at "special men".

Several "cores", similar in shape to the "horsehoof" used by the Australian aborigines, were found at Puril, an old fighting ground about one and a quarter miles from Nipa, and a fine example of a chopper formed by extensive secondary flaking was found at the same site.

Flint pebbles are found in abundance in creeks and are plentifully distributed in the soil.

Comments (by Norman B. Tindale)

The Rev. H. K. Bartlett is an experienced collector of aboriginal implements and has presented to the South Australian Museum material from many surface archaeological sites in Australia. His eyes did not fail him on a brief visit to New Guinea.

The Nipa record adds one to the relatively few reported sites for archaeological implements on the island of New Guinea. It is one of the first mining places for flaked implements to be recorded and is of particular interest because the use of primary flakes seems to have persisted up to the present time.

The three types present among the five significantly reworked flake implements found by Mr. Bartlett have been figured.

The largest specimen (fig. 1), from Puril, is a uniface cleaver-like implement worked on a large flake. The secondary working is concentrated at one end; the original material remains on the upper half of the worked face. Study of the cutting edge shows that at the angle at which an adzing cut would be effective but at no other, the stone would have presented an almost flat and level cutting edge against the wood or other substance being cut. Therefore, reasonably, it is suspected to have been an adze. Concentration of the flake scars

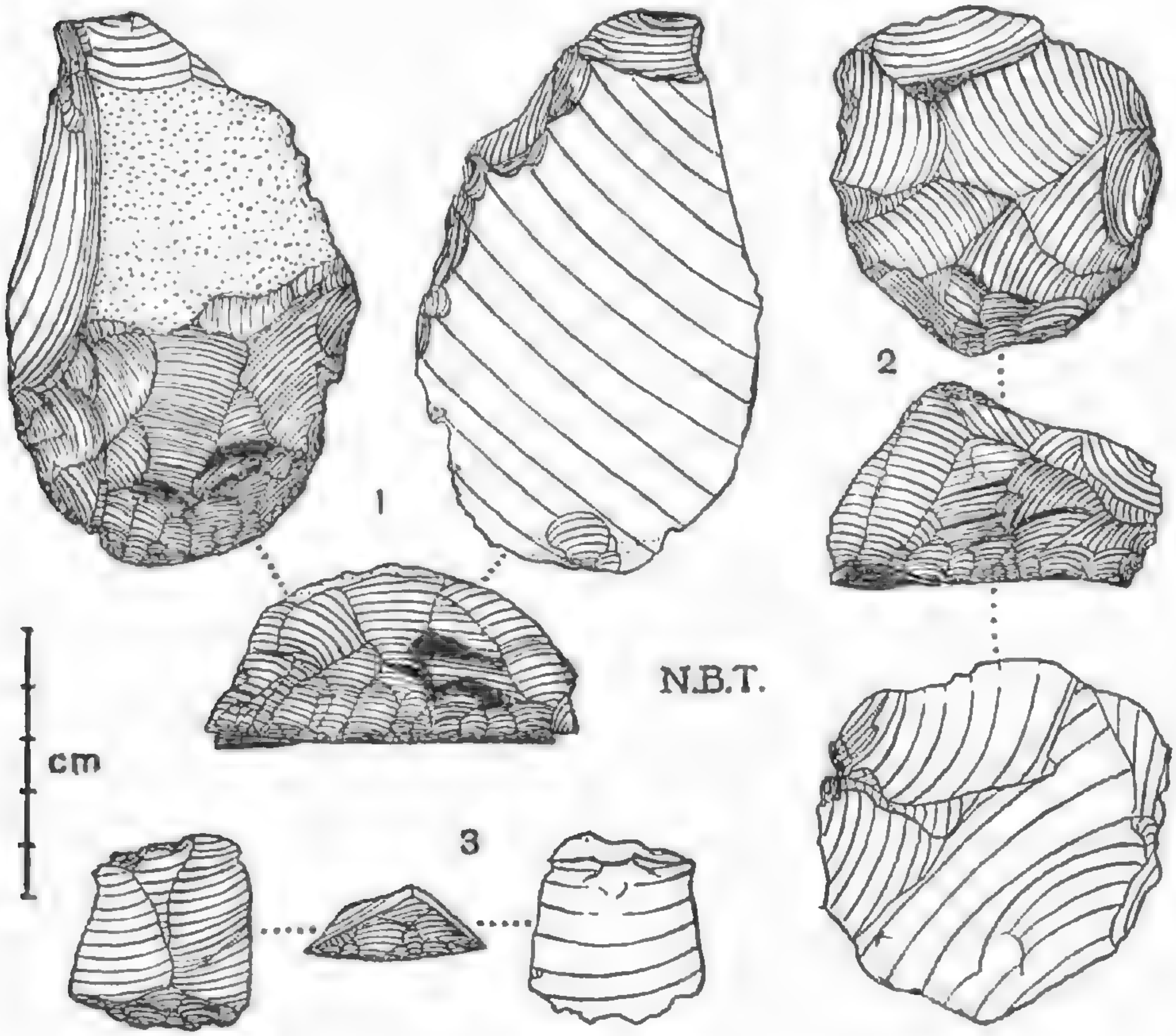

Fig. 1-3. Implements from Nenbi River, Papuan Highlands
1. Cleaver-like implement from Puril.
2. Discoidal high-backed implement from Nipa.
3. Long-bladed adze or chisel from Nipa.

implies hafting and if techniques similar to those of Australian aborigines can be inferred to have been applied the implement had been re-edged by further flaking while in the haft. The material of this implement, as of all the implements and flakes from this site, is a fine-grained gray chert, which may have been deposited from a volcanic source, since the cortex present on part of this specimen appears like a volcanic grit. The very acute cutting edge (50° angle) may suggest that the implement was used to cut some relatively soft substance. Both faces of the cutting edge show much silica-polish as if they had been chopped into a pithy substance such as sago containing hard fibres, or into stems such as those of sugar cane. Two small flake scars at the cutting edge are injuries sustained after the implement had been in use for some time and their surfaces lack the high degree of polish present on the rest of the edge.

The second specimen (fig. 2) is a discoidal high backed implement made on a block. The effectively trimmed part of the margin is confined to less than one-half of the periphery. The original block had two flakes casually removed from the upper surface and there are traces of a few scars at the opposite end of this surface which probably were made when the block was broken out; these seem a little more weathered than the rest of the work suggesting that the block may have been lying about for some time before being fashioned into its present form. The second of the three views of this implement shows the most highly trimmed edge and it is evident that the rather obtuse cutting margin (of approximately 75° angle) met the work with a straight edge. I have elsewhere suggested that in Australia implements like this probably were hafted in the manner of the *kodj* (*kodja*) axe of the present-day aborigines of South Western Australia. Objections have been made to this suggestion by those who have not had opportunities of studying the majority of the surviving hafted specimens of *kodj* axes.

There is a second specimen very similar to this high backed implement in the series from Nipa.

The third specimen (fig. 3) has been fashioned on a flake struck from a prepared platform to form a parallel-sided long blade. There is an angle of 115° between this platform and the upper or flake surface of the implement. This has been developed at the end opposite the striking platform to form a long-bladed adze or chisel. At the angle of use, if it were hafted as a chisel in the Australian manner, it would have presented an even and very slightly convex cutting edge to the work. A second example of a small long-bladed chisel or adze is not quite so parallel-sided but probably was made and used in the same way as the figured one. Its surface is polished, partly from use and possibly partly also from rolling in water after being discarded.

The collection contains ten other flakes, all without more than casual secondary trimming. Four of the flakes are semi-discoidal and thin, three others are stouter, and the rest are nondescript blades; they range up to 5 cm. in length.

The material from this Nenbi River site has been presented to the South Australian Museum and is registered under the number A.54132.

SYSTEMATIC POSITION OF THE NEW GUINEA FROG HYLELLA WOLTERSTORFFI WERNER

BY MICHAEL J. TYLER

Summary

Examination of the holotype of Hylella wolterstorffi Werner has revealed firmisternal characteristics. The species is therefore transferred from the arciferal Hylidae to the Microhylid genus Oreophryne. The holotype is redescribed and figured, and its relationships to other species discussed.

Hylella wolterstorffi Werner (1901) is based on a single specimen collected in New Guinea by Tappeubeck. The exact type locality is unknown, for the data labels accompanying the collection in which the specimen was included were either detached or illegible (Werner, 1901, p. 602).

SYSTEMATIC POSITION OF THE NEW GUINEA FROG HYLELLA WOLTERSTORFFI WERNER

By MICHAEL J. TYLER

Fig. 1

SUMMARY

Examination of the holotype of *Hylella wolterstorffi* Werner has revealed firmisternal characteristics. The species is therefore transferred from the arciferal Hylidae to the Microhylid genus *Oreophryne*. The holotype is redescribed and figured, and its relationships to other species discussed.

INTRODUCTION

Hylella wolterstorffi Werner (1901) is based on a single specimen collected in New Guinea by Tappeubeck. The exact type locality is unknown, for the data labels accompanying the collection in which the specimen was included were either detached or illegible (Werner, 1901, p. 602).

After several authors had expressed the opinion that *Hylella* Reinhardt and Lutken was a polyphyletic assemblage, *wolterstorffi* and the other New Guinea members of the genus were referred to *Hyla* by Barbour (1912). Van Kampen (1919) suggested that *wolterstorffi* might be based on a juvenile *Hyla arfakiana* Peters and Doria, but when revising the Indo-Australian members of the genus (1923) continued to regard the former a valid species.

Through the kindness of Dr. Gunther Peters of the Institut für Spezielle Zoologie und Zoologisches Museum, Berlin, the author had the opportunity of examining the holotype. As the shoulder girdle was found to be firmisternal, the presence of *wolterstorffi* in a Hylid genus cannot be maintained. The species has therefore been redescribed and figured, and its systematic position revised.

DESCRIPTION OF THE HOLOTYPE

The presence of a firmisternal girdle with reduced development of the clavicles, the absence of vomerine teeth and maxillary teeth, and the presence of T-shaped terminal phalanges indicate that *wolterstorffi* is very closely allied to the Microhylid species *Oreophryne* (*Hylella*) *brachypus* (Werner), and should also be referred to *Oreophryne*.

Oreophryne wolterstorffi (Werner)

Holotype: Z.M. 16853. One adult specimen collected in New Guinea by Tappeubeck.

There are neither maxillary nor vomerine teeth. The tongue is oval, entire and half free behind, and there is a single, denticulate pre-pharyngeal ridge. The eye is prominent, its diameter greater than the distance separating it from the naris; the snout is truncate. The tympanum is indistinct, with a horizontal diameter which is slightly more than one-third of the eye diameter.

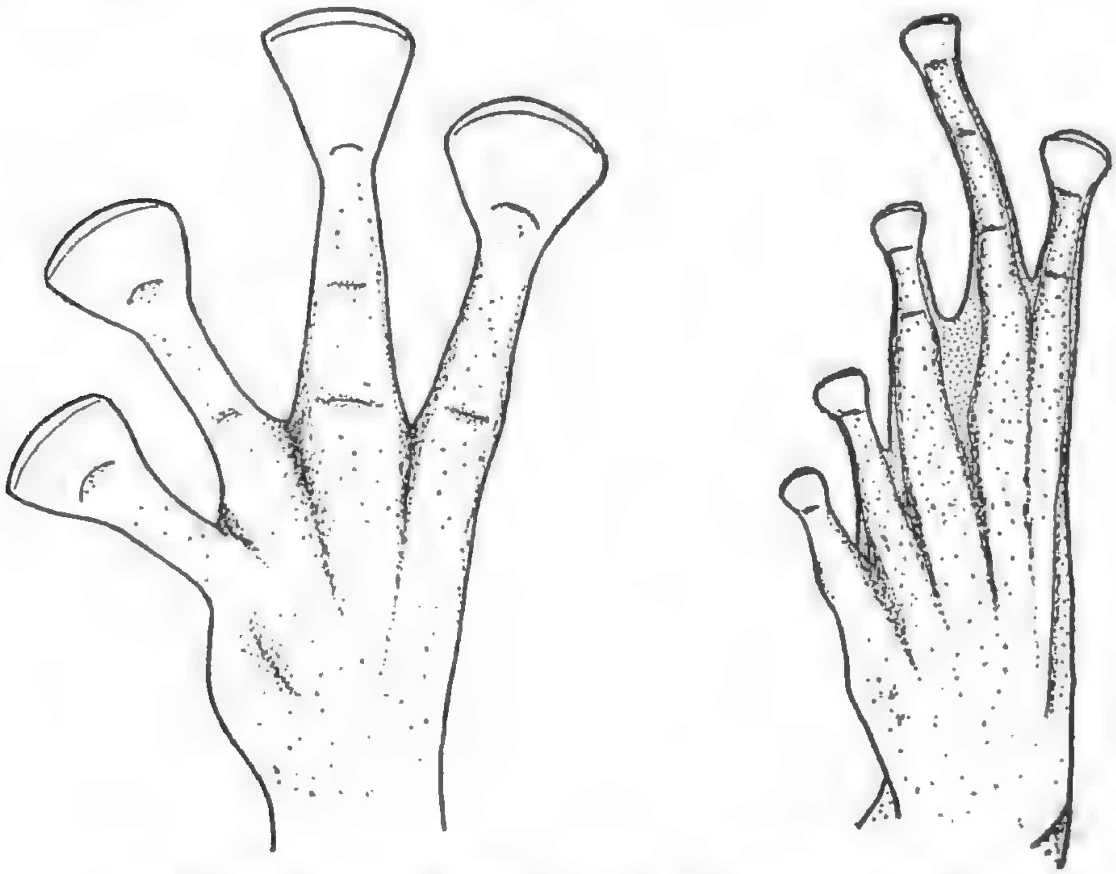

Fig. 1. Lower surface of hand and foot of *Oreophryne wolterstorffi*.

The shoulder girdle was found to be partially dissected, and only those portions of the procoracoids separating the clavicles from the coracoids are now present. The clavicles are in such close proximity to the coracoids that it is considered unlikely that the procoracoids could have extended as far as the scapulae. The posterior margin of each clavicle is obtusely angled, and the anterior margin evenly rounded. The clavicle may also be divided into two portions; the proximal portion subtends to the coracoid at an angle of approximately 40°, and the distal half lies parallel to the coracoid.

The hand is unwebbed, and the fingers bear large, truncated discs (fig. 1). There is a short basal web on the foot, and very narrow fringes to the toes. The toe discs are very much smaller than the finger discs (fig. 1). The terminal phalanges are T-shaped.

Werner described the colouration of the specimen as follows: "Whitish brown above, with grey blotches. A dark brown stripe stretches from the posterior edge of the eye above the tympanum towards the back; this stripe does not extend over the head. Anterior part of head to middle of eyes light-coloured, posterior part of head dark brown (both of these colours being distinct and clearly divided). Limbs indistinctly flecked with brown. Belly and thighs marbled with white and light brown."

The holotype is now a very pale brown, and few of the markings reported by Werner can be distinguished.

Dimensions: Snout to vent length 22.5 mm.; tibia length 9.7 mm.; head breadth 7.4 mm.; head length 7.1 mm.; eye diameter 3.1 mm.; eye to naris distance 1.8 mm.; internarial span 1.6 mm.; tympanum diameter 0.8 mm.

RELATIONSHIPS

It is possible to divide *Oreophryne* into two groups according to the extent of the development of the procoracoids (Parker, 1934). In one group the procoracoids extend to the scapulae, and in the other the distal half or one-third is replaced by a slender ligament. In view of the large number of species currently comprising the genus, this separation is a convenient taxonomic characteristic. It is therefore extremely unfortunate to find that the procoracoids of *wolterstorffi* have been destroyed.

The presence of webbing between the toes is shared by relatively few species. *Oreophryne kampeni* Parker has one-third webbed toes, but differs from *wolterstorffi* in having the third toe shorter than the fifth. *Oreophryne crucifera* (Van Kampen) and *O. albopunctata* (Van Kampen) have similar webbing, but the third and fifth toes are of equal length. The tympanum of *O. anthonyi* (Boulenger) is half the diameter of the eye (approximately one-quarter in *wolterstorffi*), whilst *O. biroi* (Méhely) has very much larger finger discs.

Oreophryne brevicrus Zweifel may be distinguished from *wolterstorffi* by smaller finger discs and a slightly protruding snout. *Oreophryne idenburgensis* Zweifel has a much larger tympanum but exhibits many characteristics common to *wolterstorffi*, as does *O. brachypus* (Werner) which is distinguished by more extensive toe webbing.

DISCUSSION

The evidence supporting the recognition of many *Oreophryne* species frequently consists of differences in the diameter of finger and toe discs, and similar minor features. Although it is sometimes possible to demonstrate the statistical significances of such differences in freshly preserved material, it is extremely difficult to make accurate comparisons when the specimens are old and dehydrated.

Although a revision of the genus may reveal that *wolterstorffi* is synonymous with one of the many species currently recognized, it is clearly distinct from those which take priority by date of publication, and should therefore remain a valid name.

ACKNOWLEDGMENTS

I wish to acknowledge my gratitude to Dr. Gunther Peters who made it possible for me to examine the holotype, and to Professor R. F. Whelan of the University of Adelaide for helpful suggestions during the preparation of the manuscript.

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PIGMY RIGHT WHALE (CAPEREA MARGINATA) IN SOUTH AUSTRALIAN WATERS, PART 2[1]

*BY THE LATE HERBERT M. HALE, HONORARY ASSOCIATE,
SOUTH AUSTRALIAN MUSEUM*

Summary

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The skull of an old example, compared to that of juveniles about nine feet in length, exhibits considerable growth changes. In all material in hand the length of the skull is approximately one-fourth of the length, or estimated length, of the entire skeleton.

PIGMY RIGHT WHALE (CAPEREA MARGINATA) IN SOUTH AUSTRALIAN WATERS, PART 2[1]

By the Late HERBERT M. HALE, Honorary Associate, South Australian Museum

Plate 48 and text fig. 1-4

SUMMARY

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INTRODUCTION

The known strandings of *Caperea* on South Australian coasts occurred in a restricted area bounded by the north coast of Kangaroo Island and the southern part of Eyre Peninsula. Also, at Victor Harbour, near the western end of Encounter Bay, and not far from Kangaroo Island, one juvenile became fouled in a fishing net in shallow inshore water. The localities are adjacent to, or at, the entrances to Spencer Gulf and Gulf St. Vincent. Although a good number of whales of other species have been seen in these gulfs, or have come ashore, there is to date no record of the Pigmy Right Whale travelling north into them, or coming to grief in the shoals there as have many other whales.

Seven definite records of *Caperea* in South Australia are now available; two are from the north coast of Kangaroo Island, the one accidentally netted at Victor Harbour, three from Port Lincoln Bay, on the western side of the wide entrance to Spencer Gulf (south-eastern coast of Eyre Peninsula) and one from Coffin Bay on the west coast of the Peninsula, opposite to, and only 30 miles from, Port Lincoln, which is one of South Australia's foremost fishing ports, situated on Boston Bay, immediately north of Port Lincoln Bay.

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(1) Part 1, *see* Records South Aust. Mus., iv, 1931, pp. 314-319, fig. 1-4.

The last example to be observed was an adult female which came ashore on August 16, 1960, on mud flats near "Tulka" (referred to below) in Port Lincoln Bay, in an advanced stage of decomposition. Unfortunately, because of urgent commitments, this specimen could not be secured at the time, and subsequently it disappeared.

On July 7, 1960, a *Caperea* accompanied by its calf was seen in Port Lincoln Bay and it seems probable that the female was the one stranded five weeks later.

Guiler (1961, p. 297) records a pregnant female stranded on a Tasmanian coast towards the end of June, 1961.

Some years ago the writer prepared a popular article, published in country newspapers, detailing the characters by which whales, particularly small and insufficiently known species, may be recognized. Following this, and the 1960 stranding, officers of the Fisheries and Game Department at Port Lincoln stated that it is not uncommon for Pigmy Right Whales to appear in "Proper Bay" (the local name for Port Lincoln Bay) during the winter and that from time to time several had been stranded near "Tulka" but had not been reported.

Port Lincoln Bay shoals towards its western end, where extensive mud flats are exposed at low tide. Whales occasionally come ashore on these flats, particularly in the vicinity of "Tulka", a homestead at the south-western part of the Bay and eight miles from Port Lincoln town. The same thing occurs in Coffin Bay.

J. E. Hamilton (1952, p. 2) suggests that Byron Sound in the West Falkland Island may act as a "sort of trap" and "that panic at finding themselves in narrow and shoaling waters may have resulted in the stranding of these whales", viz., *Globicephala, Physeter, Orcinus, Balaenoptera* and the Pigmy Right Whale. This pertinent suggestion might well apply to the bays of southern Eyre Peninsula, while the Kangaroo Island strandings of *Caperea* occurred in shoal waters partly enclosed by a long sand bank locally known as "The Spit".

An eighth record is afforded by a tympanic bone recorded by Zeitz (1890, p. 8) who stated, after recording the occurrence of the juvenile from Victor Harbour "besides which there is an ear bone from the former locality". This bone has not yet been located in the Museum collections, but the identification is assumed to be correct as Zeitz had the advantage of direct comparison with the tympanics of three other skulls.

MATERIAL IN SOUTH AUSTRALIAN MUSEUM

The specimens housed in the Museum, dealt with herein and in Hale, 1931, are as follows:

M.1593. Sex unknown. Mounted skeleton with some bones missing. Brownlow, north-east coast of Kangaroo Island. Stranded October 21, 1884.

M.2966. Young male. Disarticulated skeleton and baleen. Victor Harbour. Entangled in fisherman's net. September 13, 1887.

M.2967. Young male. Plaster cast of head. Point Marsden, north-eastern coast of Kangaroo Island. Stranded October 21, 1889.

M.5753. Juvenile, sex unknown. Skull and part skeleton. South-western end of Port Lincoln Bay. Stranded prior to 1948.

M.6110. Young male. Disarticulated skeleton. South-western end end of Port Lincoln Bay. Stranded December 26, 1955.

M.6111. Adult, sex unknown. Coffin Bay. Stranded about 1950.

M.1593. Brownlow, Kangaroo Island

Neobalaena marginata Hale, 1931, p. 314.

The articulated skeleton previously briefly described by me is that of one of "three individuals in the flesh . .. . received at the Museum" (Zeitz, 1890, p. 8). The skeleton now hangs in a position where it is more easily accessible than before. In 1931 the vertebral counts was given as cervical, 7; thoracic, 17; lumbar, 3; caudal, 14. In view of the fact that the sternum, first chevron and bones of the left limb are missing, it is probable that a seventeenth short and slender pair of ribs were also lost through careless maceration. In such case the thoracics number 18 and the lumbars 2, an attachment for the first and missing chevron being present posteriorly on the centrum of the second lumbar.

This Kangaroo Island example was about 16 feet in length.

The skull of this example is in general as shown in Beddard's figures (1903, pl. VII-IX), with the vertex not much posterior to the nasal bones.

M.2966. Victor Harbour, young male

Neobalaena marginata Hale, 1931, p. 315, fig. 1.

Skull 70 cm. in length (see table 1). A specimen nine feet in body length.

Skull. Viewed from the side the supraoccipital rises in the posterior half to form a rounded elevation, so that the vertex of the skull is well behind the middle of the length of the supraoccipital. In front of the tumidity the contour is concave, with a median longitudinal ridge extending from the anterior end of the supraoccipital to the vertex. About 2 cm. anterior to each occipital condyle there is a well marked low elevation, 3-4 cm. in diameter.

The nasals, where exposed, are symmetrical, the inner faces fused ventrally but separated above by a deep groove for the whole length of the bones, including the anterior ends.

Vertebrae. In my first record of this example I stated that the epiphyses are "not, or not completely, anchylosed". In fact, as far as can be made out, the epiphyses are all free but several show traces of a composition which had been used to fasten them to the centra.

The cervicals are fused but are not thoroughly coalesced. The postero-lateral portions of the neural arches of the last two are incompletely anchylosed while between the centra of five to six there is on the left side a slit through which may be seen the edges of the remnants of the epiphyses. Again, the centra of the sixth and seventh are completely fused only in the ventro-lateral parts of the left side, while fusion has begun on the right side in the same position; otherwise the centra are narrowly separated and between them can be seen the remains of the two epiphyses; the upper portions of these last, comprising the dorsal halves of the epiphyses, are fused ventrally, while below the visible lateral edges of the lower parts of the epiphyses are anchylosed. The cervical mass is wider than high (165:130); the combined dorsal processes are equal in depth to the neural canal, with the contour of the upper edge convex.

The first thoracic, as in the other thoracics, has the neural arch complete and has a short dorsal process, rounded apically and subtriangular when viewed from the side; the neural canal is very slightly deeper than wide, its depth less than one-third the total height of the vertebra (cf. M.5793, etc.).

In the second to sixth thoracics the neural canal is deeper than wide (cf. M.5753); the dorsal process of the third is wide, little more than one-third of the total depth of the vertebra, with subparallel sides, and the height less than one and one-third times the greatest width (48:38).

The fourth to fifteenth thoracics have the dorsal process longer and wider, dilated towards the distal end which is subtruncate; the tenth has a dorsal process which is one-half the total height of the vertebra, and with its greatest width much less than half its height (54:80).

The neural canal becomes an open groove on the seventh caudal.

Ribs. See table 2.

Sternum. See fig. 1.

Remarks. It will be noted in table 1 that there is less difference between the overall and condylobasal lengths of the skull of the Victor Harbour male than that of other skulls described herein; this is due to the lesser backward prolongation of the exoccipitals, etc.

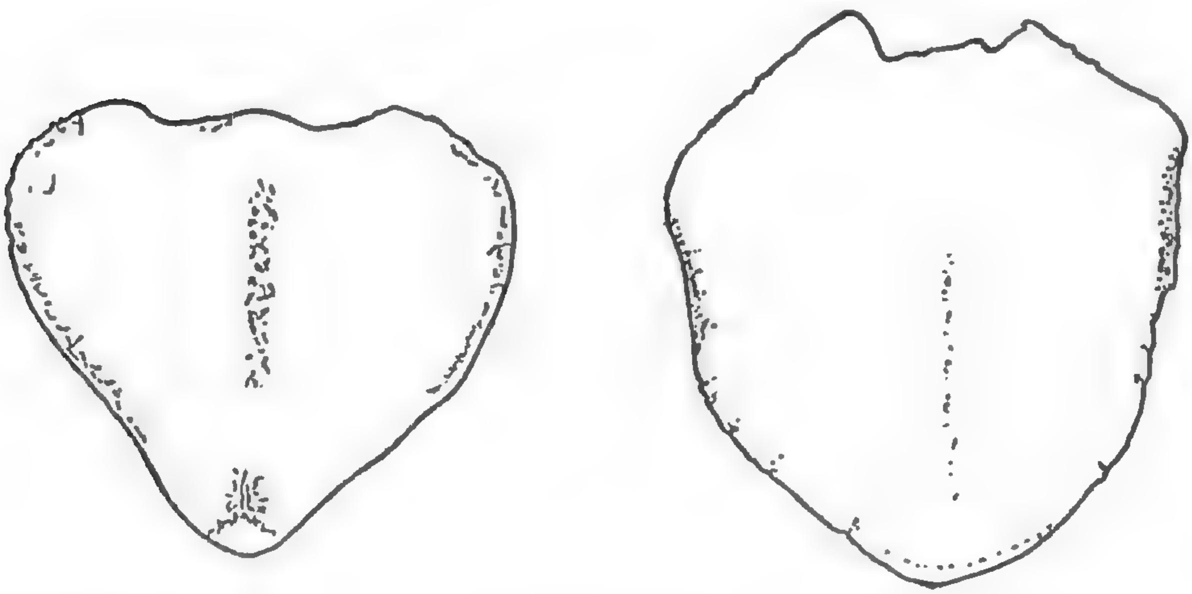


Fig. 1-2. Ventral side of sterna of *Caperea,* from specimens nine and ten feet in body length (x 5/7).

M.2967. Point Marsden, Kangaroo Island.

Neobalaena marginata Beddard, 1903, p. 107; Hale, 1931, p. 316, fig. 2 and 3.

First five cervicals completely fused; neural arches and centra of sixth and seventh partly free. Epiphyses of vertebrae not fused with centra. Seventeen pairs of ribs (*vide* Beddard). Young male, almost 11 feet in length (*vide* Hale following Stirling's unpublished notes).

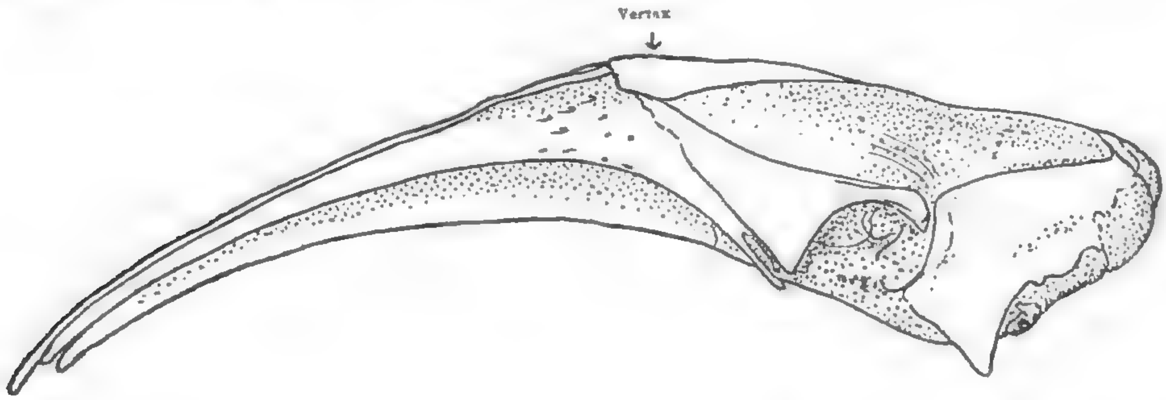
Skeleton in Cambridge University Museum. Plaster cast of head in South Australian Museum.

M.5753. Port Lincoln Bay. Sex unknown.

Skull 67 cm. in length (see table 1).

A young example stranded prior to 1948; judging by the length of the skull the total body length would have been no greater than that of the Victor Harbour young male (M.2966 herein) previously recorded (Hale, 1931, pp. 315-316, fig. 1, and Davies and Guiler, 1957, pp. 58-582.)

The following bones of specimen M.5753 were subsequently brought to the Museum by Mr. G. Cramer.



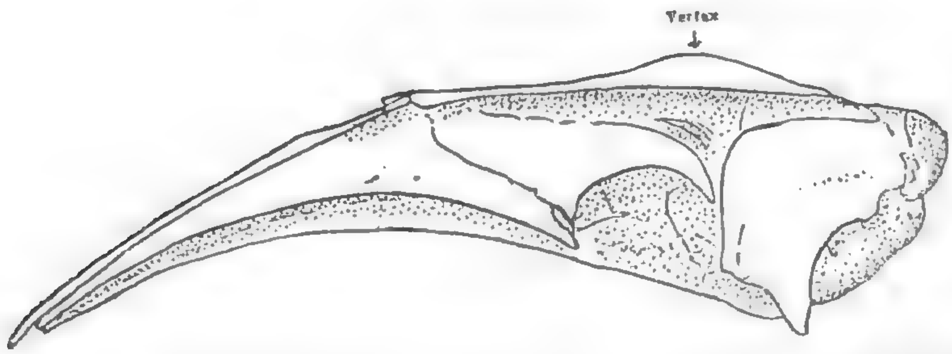


Fig. 3-4. Skulls of *Caperea*; 3, 670 mm., and 4, 1,575 mm., in overall length (scales very disproportionate).

Material. Skull, with squamosal and exoccipital of one side missing; rami of lower jaw with distal portions missing. There were seventeen pairs of ribs but in the first, sixth to eighth and fourteenth only one of the pair was recovered. Cervical vertebra; eleven thoracics, only one to four in sequence; six of the caudals, the first five in sequence; a few chevrons.

Skull. Fig. 3. As in the Victor Harbour young male (M.2966), the greatest height occurs in the posterior half of the supraoccipital, where there is a similar marked rounded hump at the level of the postero-lateral angles of the frontal; anterior to this the supraoccipital is shallowly concave, with the median longitudinal ridge short and becoming obsolescent well in front of the abovementioned tumidity. This supraoccipital hump rises above the dorso-lateral edges of the supraoccipital when the skull is viewed from the side. There is also a small and low dorsal tumidity in front of, and about 2 cm. from, each occipital condyle.

Nasals, where exposed, symmetrical, completely fused, the junction represented by a shallow groove which does not reach the anterior ends.

Vertebrae. Epiphyses are completely free on the posterior face of the centrum of the last cervical and on both anterior and posterior faces of all other vertebrae available.

All cervicals are fused into a solid mass excepting that anchylosis is asymmetrically not fully complete in the lateral parts of the posterior neural arches. The mass is nearly half as wide again as deep (195:135) and the combined dorsal processes are low, subequal in depth to the neural canal, and in profile gently convex, highest at anterior third of length.

The first thoracic has the neural arch complete, with a short rounded dorsal process; the depth of the subtriangular canal is equal to one-third of the greatest height of the vertebra and is distinctly wider than deep. In the second thoracic the neural arches are separated dorsally (3 to 4 mm.). The third and fourth have the neural canal a little wider than deep; the dorsal process of the third is narrow and tapering to the apex; it is approximately one-third the depth of the vertebra and is about twice as high as its greatest width; that of the fourth is longer and wider, rounded on upper edge. The thoracic presumed to be the tenth has the dorsal spine with upper margin semicircular, the sides subparallel, and with greatest width less than half its height (45:83); as with the other available thoracics this process is not at all constricted in the proximal half, and is equal to about one-half the total depth of the vertebra; the neural canal has become smaller than in the preceding vertebrae and is as wide as deep.

Ribs. See table 2. The first is less dilated at the distal end than in older examples and also in one of the first pair in M.2966. This may be due to erosion during maceration, or, possibly, the first ribs in the young are not necessarily symmetrical.

Scapulae. Deeper than in M.2966 and with acromion wider and coracoid about twice as long.

Remarks. Apart from the scapulae the most apparent differences from the skeleton of the Victor Harbour young male, M.2966, which is of comparable size, are the shorter anterior dorsal carina on the supraoccipital, the completely fused nasal bones, and the larger vertebrae in relation to the skull length, with the dorsal processes of the thoracics dissimilar in shape; there is also some variation in the ribs (see table 2).

M.6110. Port Lincoln Bay. Young male.

Skull 84 cm. in total length (see table 1). A juvenile 10 feet in body length, collected by members of the Museum staff.

This example was noticed swimming sluggishly on or about December 25, 1955; it was stranded on December 26 near "Tulka", 8 miles south of Port Lincoln, and was then photographed by Mr. Howard W. Dorward and Mr. C. L. Gill (see plate 48); these, as in the other photographs published by me in 1931, show the white band along the upper jaw and above the baleen, referred to by Davies and Guiler (1957, p. 581).

A fisheries inspector, Mr. D. E. Barnes, informed us of the stranding and the specimen was "fleshed" on the spot by two members of the Museum staff on January 6, 1956. It was then noted that the unfortunate creature had been peppered with bullets from a small calibre rifle; the specimen by this time was considerably decomposed, so no colour notes were possible.

Material. Complete skeleton, but with dorsal processes of six thoracics damaged.

Measurements in the flesh.

	mm.
Total length, in a straight line, to middle of tail flukes	3,050
Tip of snout to eye	685
Tip of snout to genital slit	2,140
Tip of snout to origin of dorsal fin	2,230
Tip of snout to axilla	1,070
Length of eye	40
Length of gape	610
Length of dorsal fin (approximately)	155
Height of dorsal fin	155
Greatest length of pectoral limb	305
Width of caudal fin	610

The above measurements were secured by the collectors, Messrs. G. F. Gross and A. Rau. It was noted that the caudal fin had a central notch.

Skull (see table 1). The supraoccipital is elevated in the posterior half but distinctly less so than in the two smaller examples (M.2966 and 5753). Also, the median dorsal ridge is conspicuous, almost continuous, fading out about three inches before the anterior end of the bone and not quite reaching the foramen magnum. The anterior part of the supraoccipital, in front of the low dorsal hump, is more elevated than in that of the skulls of the two young about nine feet in length. The dorso-lateral occipital edges are strongly produced, not evenly curved as in the smaller skulls, but sinuous and slightly upturned at about the middle of their length. The low dorsal tumidities in front of the condyles are still apparent.

The exposed parts of the nasals are fused but the dorsal groove is rather wide and deep. No suture is apparent between the fused basihyal and thryohyals.

Vertebrae. Cervical, 7; thoracic, 18; lumbar, 2; caudal, 15; chevrons, 6.

The cervicals are fused together but not completely so; the lateral processes of the last five are partly free on both sides while the centra of the sixth and seventh are defined by a pair of very short lateral slits, inside which may be seen, in each, remnants of the two epiphyses; ventrally there is a short space between the sixth and seventh, again with the fused remains of a pair of epiphyses. The greatest width, across the lateral processes of the first cervical, is much greater than the height (202:142) and the combined dorsal processes, which slope forwards, are subequal to the depth of the distinctly wider than deep neural canal.

Epiphyses are completely free on the last cervical (posterior) and all other vertebrae, both fore and aft.

The first thoracic has the neural arch complete, the distally rounded dorsal process one-fifth the total height of the vertebra and the neural canal wider than high. In the second the width of the canal is subequal to the height, in the remaining thoracics it is higher than wide. The dorsal process of the third to eleventh thoracics are broad, slightly dilated and rounded at distal ends.

In the caudals the neural canal becomes a short open groove on the eighth.

Ribs (see table 2). The first rib, relatively, is more expanded than in other young examples examined, including that of the mounted specimen M.1593, and also in this rib as illustrated by Beddard (1903, pl. IX, fig. 6). Its length is less than two and one-half times the distal width, and its breadth distally exceeds the greatest width of any of the other ribs.

Sternum. Fig. 2. Irregularly subcordate, longer than wide, concave above for anterior three-fourths of length and with well developed, elongate and asymmetrical articular facets for attachment of first ribs.

Scapulae. As shown by Beddard (1903, plate VI) but with upper edges not at all sinuous, but evenly curved.

Remarks. The photographs reproduced on pl. 48 herein show the "bowhead" character referred to by Davies and Guiler (1957, p. 580, fig. 1).

M.6111. Coffin Bay, Eyre Peninsula. Sex unknown

Skull, 157.5 cm. in total length (see table 1). Part skeleton of a fully adult example collected by members of the Museum Staff.

Material. Skull and mandibles. Vertebrae: cervical, 7 and 30 other vertebrae. In the absence of a complete suite of ribs it is assumed that 18 are thoracic, 2 lumbar, and caudal 10 plus ? Scapulae are available but the sternum, pelvic bones and chevrons are missing.

The bones noted above, before recovery for the Museum, were standing under a tree on the property of the late Mr. J. Mortlock. A fisherman who knew of the stranding of this large example stated that it came ashore about 1950. Mr. J. G. Haggarty, then caretaker of the Mortlock station, later supplied a photograph of the animal secured soon after it was stranded and this shows the "bowhead" as illustrated by Davies and Guiler (1957, fig. 1). In the paper of the last named authors the locality, as supplied by me, is given as Port Lincoln, but subsequent enquiry revealed that the animal was stranded on a beach at the entrance of Coffin Bay, in the south-western coast of Eyre Peninsula and opposite to Port Lincoln on the south-eastern coast. A Sperm Whale, 42 feet in length came ashore here in late May, 1956, and from reports of a late officer of the Fisheries and Game Department, then stationed at Port Lincoln, Coffin Bay also is a "trap" for whales.

The length of the skull, as supplied to me (4 feet, 7½ inches) and sent to Dr. Guiler, is obviously the length from the anterior margin of the foramen magnum to the tip of the rostrum whereas the overall length is 1,575 mm. Thus it is apparently the largest skull known to date and it would seem that the body length of the animal may have been somewhat in excess of 21 feet. The vertebrae indicate that it was an old individual.

It is possible that there are other discrepancies in the lengths of skulls given by Davies and Guiler, as for example in the Kawau Island skull, in which the skull length was taken from "snout to occipital foramen".

Skull (see table 1). There is a marked difference in the dorsal profile with that of examples with skull 67 cm. to 70 cm. in total length. The dorsal ridge is strongly elevated for almost the anterior two-thirds of the supraoccipital and the vertex occurs immediately behind the nasals.

The sharp-edged occipital expansions are much more prominent than in smaller skulls, and for the posterior two-thirds of their length are inclined upwards instead of slightly downwards, so that, viewed from the side, the posterior part of the profile of the supraoccipital is not visible, as it is in the small skulls.

For about one-third of the length of the supraoccipital the dorsum is flattened and the pair of bosses immediately above the condyles are obsolescent.

Vertebrae. The epiphyses are thoroughly fused, and incorporated with, the centra of all vertebrae available.

The cervicals are fused into a solid mass excepting for the usual elongate foramina between the lateral processes. There are traces of the fusion of the dorsal processes in the last three, most distinct in the sixth-seventh. The combined dorsal processes are more elevated than in the young and the mass is relatively wider (420: 270); the width in relation to the height remains approximately the same, however, the greater elevation of the dorsal processes having been accompanied by a proportional widening of the lateral processes of the mass.

There is a prominent facet on each side of the dorsal processes of the first and second vertebrae, oval in shape, and 30 to 40 mm. in depth.

The first thoracic, as in the other dorsal vertebrae, has the neural arch complete; the neural canal is deeper than wide. The canal is markedly deeper than wide in the second, and is deeper than wide in all of the other thoracics. The dorsal processes, apart from that of the cervicals, are much as figured by Beddard but from the eighth backwards the apex is rounded, allowing for the fact that the seventh is broken; in any case, this is a variable feature. The lateral processes are relatively wider than in younger examples, particularly noticeable from the tenth backwards.

In the eighth caudal the neural canal becomes a very short open groove.

Ribs (see table 2). Only eight pairs, third to eighth, eleventh and fourteenth, are amongst the total of twenty-two individual ribs in hand; none is available posterior to the fourteenth. The eleventh to fourteenth are damaged proximally and distally so that their lengths given in the table must be taken as approximate.

There is a marked thickening of all ribs, particularly apparent in the posterior ones as compared to the condition of the very young in which the dilation is almost wafer-like as the hinder edge is approached.

Scapulae. Much as figured by Beddard (1903, pl. VII). The dimensions are: width 53 cm.; depth 30 cm.

SKULLS

TABLE 1. THREE JUVENILES, 9 FEET TO 10 FEET IN LENGTH, AND ONE ADULT, C. 21 FEET

Registration Number....	M.2966		M.5753		M.6110		M.6111	
Measurements	mm.	Per Cent	mm.	Per Cent	mm.	Per Cent	mm.	Per Cent
Overall length	700	100·07	670	104·68	840	103·70	1,575	105·70
Condylobasal length	695	100·0	640	100·0	810	100·0	1,490	100·0
Length from anterior margin of foramen magnum to end of rostrum	655	94·2	565	88·2	760	93·8	1,420	95·3
Length of supraoccipital from anterior margin of foramen magnum	265	38·1	290	45·3	315	38·8	570	38·2
Anterior end of supraoccipital to tip of rostrum	390	56·4	275	42·9	445	54·9	850	57·0
Postero-lateral processes of maxillae to end of rostrum	475	68·2	430	67·1	570	70·3	1,105	74·1
Postero-lateral processes of maxillae to level of posterior of exoccipitals	225	32·3	240	37·5	270	33·3	470	31·5
Depth of maxilla at level of anterior margin of supra-occipital	98	14·1	100	15·6	98	12·1	195	13·0
Greatest height of skull	205	29·5	205	32·0	210	25·9	470	31·5
Width between squamosals	370	53·5	—	—	410	50·6	770	51·6
Width between postero-lateral processes of frontals	330	47·4	365	57·0	380	46·9	750	50·3
Width of frontal at concave outer margin	95	13·6	103	16·0	115	14·2	180	12·0
Width across occipital condyles.	115	16·5	125	17·9	120	14·8	205	13·7
Length of mandible	550	79·1	—	—	680	83·9	1,280	85·9
Depth of mandible at coronoid..	75	10·7	75	11·7	85	10·4	185	12·4
Depth of mandible at middle of length	60	8·6	80	12·5	80	9·8	225	15·1

M.2966 and M.6110 are young males; the sex of the other two is unknown.

M.2966 and M.6110 are young males; the sex of the other two is unknown.

In these young males, where the length of the animal is known (nine and ten feet) the skull is less than four times in the total length of the skeleton, while in a Kangaroo Island specimen about 16 feet in length (M.1593 herein), it is only slightly more than four times in the length. In Beddard's figure of a skeleton a little more than 13 feet in length, the proportions are shown as four and one-half times in the total length, although this author states "The proportions of the length of the skull to that of the entire skeleton including the skull are as 1:5½" (Beddard, 1903, p. 101, and pl. VII).

All length measurements, and the heights of the skulls, in table 1 are parallel to, and at right angles to, a median base-line, taken from the level of the ventral angles of the squamosals to the anterior ends of the premaxillae. The length along the curve of the arched profile, obviously, is in excess of that of the base-line, but not to the extent one would expect from the appearance of the skulls oriented as noted above. There is some variation in the degree of arching. The percentage of the base-line distance from the foramen magnum to the end of the rostrum, as against measurements from the same points along the curve of the dorsum is 105 (M.2966), 114 (M.5753), 108 (M.6110) and 110 (M.6111). In the young male ten feet in length (M.6110) the skull is more depressed than in the others and has the supraoccipital considerably longer in proportion to the condylobasal length, although less convex dorsally. The median length of the dorsal curve of the two smallest skulls is affected by the prominent posterior supraoccipital hump, which is much lower in M.6110 and absent in the adult.

In the skull of M.2966 the distance between the occipital condyles and the posterior level of the exoccipitals is very short, only one-sixth of that in the other two small skulls.

The relative depth of the maxillae, measured from the point where they reach the premaxillae at the anterior end of the supraoccipital, is variable, and may differ in the right and left bones, in which case the greater depth is cited in the table.

Measurements alone do not demonstrate adequately the differences between the largest skull and that of juveniles. A review of the limited number of South Australian skulls available shows that the posterior supraoccipital hump, the rounded summit of which is the vertex, is a character of the very young. This tumidity becomes far less prominent after a body length of ten feet is attained (Beddard's 1903 figures show little indication of it beyond a slight elevation of the median dorsal ridge anterior to the "O" on his fig. 1 on pl. IX). In the larger of the Kangaroo Island specimens, with the skeleton almost 16 feet in length, the vertex is not far back from the anterior end of the supraoccipital and the carina behind this is continuous, slightly concave and rising very little at the site of the juvenile rounded hump.

In the skull, over 157 cm. in length, of the old adult the posterior part of the otherwise strong median dorsal ridge is flattened, with no indication of an elevation—in fact the carina begins to curve upwards at a point about one-third of its length from the foramen magnum; thence it is but little curved in profile and is slightly concave not far posterior to the short gentle convexity before the anterior end of the supraoccipital.

The sharp-edged lateral occipital ridges also alter with growth. The skulls 67 cm. and 70 cm. in overall length have their margins evenly curved and very slightly bent down excepting near the anterior ends. In the male ten feet in length, with 84 cm. skull, the lateral ridges show indications of upturning at about the middle of their length. The 123 cm. skull of the Kangaroo Island specimen exhibits a more apparent upturn of the ridges, particularly in the exoccipital-squamosal part, so that in sideview the median dorsal carina is hidden at the extreme posterior end (see also Oliver, 1922, pl. 1). In the old adult, with skull 157.5 cm. in length, the uprising of this lateral ridge hides the posterior half of the supraoccipital when the skull is viewed from the side (cf. fig. 3 and 4 herein). It must be noted that the last-named drawings are from photographs taken to show the dorsal contour of the skull: therefore there is some distortion of the lateral parts, particularly apparent in the frontal and squamosal.

The mid-length depth of the mandibles increases, relatively, with age, but on the other hand the bulla of the ear bones of the young is not only smoother, but proportionately strikingly larger, than in the adult or even in an example 16 feet in length.

In the last pair of ribs the width-length is taken from the longer of the pair. The ribs of the young male M.6110 were tagged in sequence as they were removed from the carcass.

Beginning with the eighth pair the widening of the posterior ribs, so marked in all but the last, becomes apparent; the length of the ribs in table 2 is taken in a straight line from head to distal end.

BONY RIBS

TABLE 2. GREATEST WIDTH OF BLADE TO LENGTH OF POSTERIOR RIBS OF THREE JUVENILES AND ONE ADULT

Reg. No.	M.2966			M.5753			M.6110			M.6111		
Rib	Width	Length	Per Cent	Width	Length	Per Cent	Width	Length	Per Cent	Width	Length	Per Cent
8	35	398	8·7	38	380	10·0	35	450	7·7	55	870	6·3
9	42	420	10·0	55	385	14·2	45	485	9·2	—	—	—
10	47	416	11·3	55	395	13·9	60	495	12·1	—	—	—
11	45	422	10·6	56	405	13·8	60	510	11·7	85	900	9·1
12	50	410	12·1	60	420	14·2	60	500	12·0	120	850	14·1
13	51	375	13·6	65	425	15·2	65	495	13·1	150	800	18·7
14	40	340	11·7	65	430	15·1	62	470	13·1	140	750	18·6
15	30	273	10·9	60	425	14·1	50	415	12·0	—	—	—
16	16	205	7·8	40	320	12·5	35	340	10·3	—	—	—
17	—	—	—	25	280	8·9	19	250	7·6	—	—	—

With the material in hand the data are too meagre to allow any very definite conclusions, particularly as so many of the posterior ribs of the adult are missing and those available are more or less damaged. However, in the four examples the thirteenth rib is widest in relation to the length while in general the eighth to eleventh tend to become longer in proportion to the width.

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EXPLANATION OF PLATE 48

A young male *Caperea marginata*, ten feet in body length, stranded on flat at Port Lincoln Bay (upper photograph by courtesy Mr. H. W. Dorward, lower by Mr. C. L. Gill).

A NEW METEORITE FIND FROM SOUTH AUSTRALIA

By David W. P. Corbett, Curator of Fossils and Minerals, South Australian Museum

Summary

The external features, mineralogy, and structure of a new aerolite from the Millicent area of South Australia are described. Four stones, found within an area of a half-mile radius, are evidently individuals of a meteorite shower. A fifth stone, discovered forty-two miles to the north, shows certain external and textural differences from the remainder of the group, but is believed to be a part of the same fall, which is here named the Lake Bonney Meteorite.

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Plates 49-51 and text fig. 1

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The external features, mineralogy, and structure of a new aerolite from the Millicent area of South Australia are described. Four stones, found within an area of a half-mile radius, are evidently individuals of a meteorite shower. A fifth stone, discovered forty-two miles to the north, shows certain external and textural differences from the remainder of the group, but is believed to be a part of the same fall, which is here named the Lake Bonney Meteorite.

INTRODUCTION

A stony meteorite weighing 1.9 kg. was discovered by Mrs. B. G. McDonald of Millicent on October 21, 1961, in sand dune country between Lake Bonney and the sea, thirteen miles S.S.W. of Millicent township in the South-East of South Australia. Three further stones were discovered on subsequent visits to the area. The four stony meteorites have a complete fusion crust and are not the broken fragments of one large mass. One of the stones was found shattered into several pieces and scattered over a distance of five square feet. The pieces are easily put together, and the shattering is believed to be of recent date.

Weights of the four finds are given below, and their locations shown on the locality map. The numbers refer to specimens registered in the Mineral Collection of the South Australian Museum.

G.7345	.. ..	1.96 kg.
G.7346	.. ..	538.64 grams—(total weight of fragments)
G.7347	.. ..	56.70 grams
—	.. ..	205.55 grams

The four stones were all found within an area of a half mile radius, close to the small peninsula known as Jacky Point, which projects north-eastwards into Lake Bonney. The co-ordinates of Jacky Point are 37° 45′ S., 140° 18′ E. In addition, a further stone of 283.5 grams (G.7579) was found, also by Mrs. McDonald, at Nora Creina Bay, forty-two miles along the coast to the north-west.

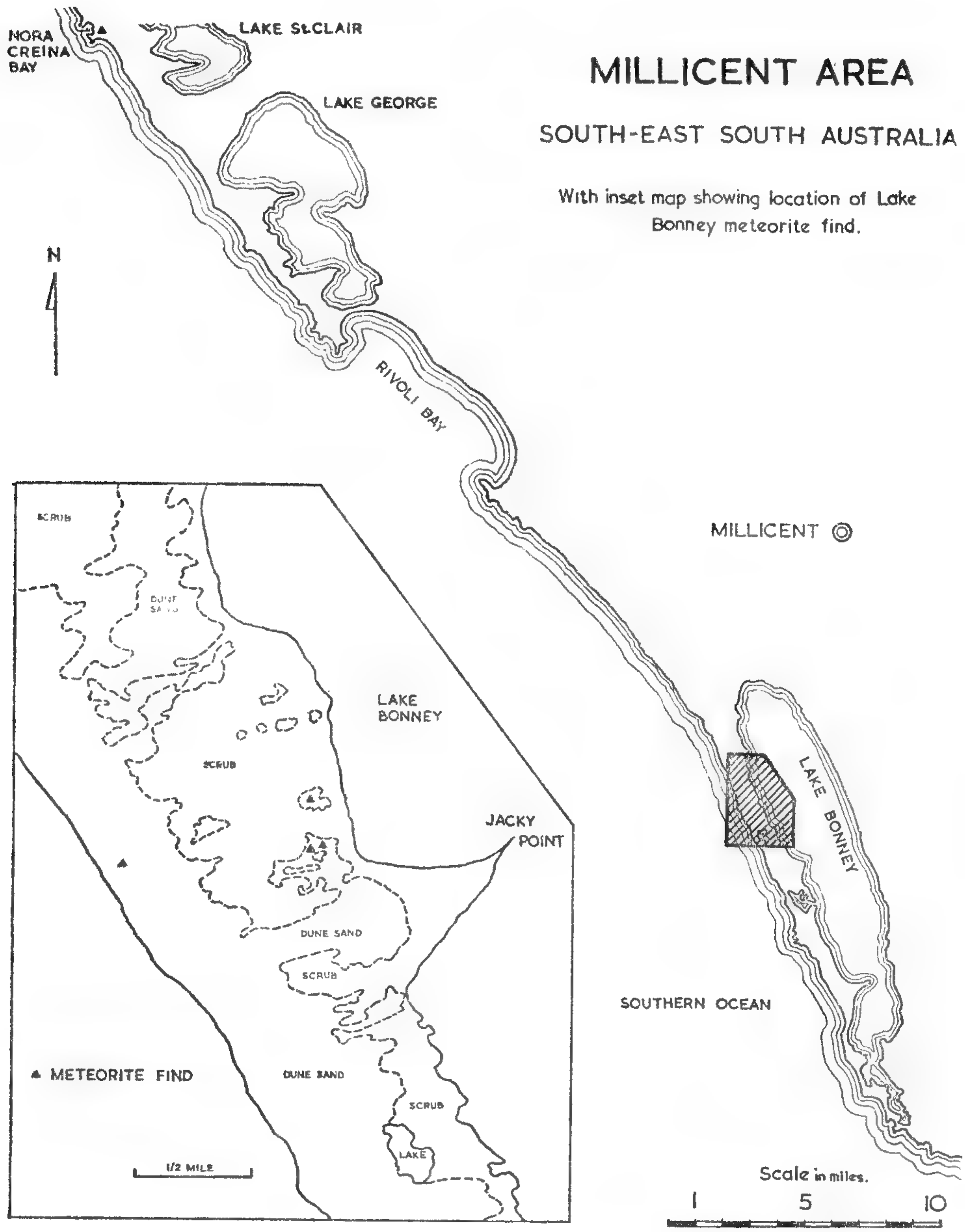

Fig. 1. Map of Millicent area, South-East of South Australia, with inset map showing location of Lake Bonney meteorite find.

LOCATION OF FINDS

The strip of dune country between Lake Bonney and the sea averages one mile in width. The more stable dunes carry a scrub vegetation, but most of the area is subject to drift. After leaving the the road from Millicent, access at the northern end of the lake is restricted to four-wheel drive vehicles, and the region is largely unfrequented.

Because of the highly unstable environment in which the finds have been made, stones lying on the surface can be uncovered and covered again very quickly by drifting sand. It is highly probable therefore, that other stones remain to be found in the area. The Nora Creina find was located in a similar dune sand environment within a half mile of the sea.

NATURE OF FALL

The concentration of four of the five finds in the Jacky Point area suggests that the original fall occurred in this vicinity, and that it was in the form of a shower of stony meteorites. No evidence is available for the direction of the fall, but it is probable that part of the shower fell into the sea and part into the lake. If the Nora Creina stone was found *in situ,* and is also a part of the Lake Bonney fall, the area of the strewn field was considerable, the long axis of the distribution ellipse being over forty miles long. Alternatively, as the general drift along the coast is to the north, it is conceivable that the Nora Creina stone could have been transported northwards and finally washed ashore. If this possibility is acknowledged, then further stones could be found anywhere along the coastal strip north from Lake Bonney.

A further possibility, considered to be the most likely, is that the stones have been transported by aborigines at some time in the past. Support for this view is given by the numerous native campsites in the area, and the fact that one of the stones was found in close proximity to one of these sites.

From the available evidence it is concluded that the Nora Creina stone, although showing some differences from the Lake Bonney group, is part of the same fall. It will therefore be included as an individual stone of the group, which is here named the Lake Bonney Meteorite and is described below.

DESCRIPTION OF THE LAKE BONNEY METEORITE

External Features

The largest stone (G.7345, plate 49, A) is a roughly equi-dimensional block, very tough and compact and brownish-black in colour. The flat surface shown at the base of the photograph is believed to be a fracture surface. The stone is completely covered by a fusion crust with an average thickness of 0.5 mm. The orientation of the meteorite during flight can be determined, and frontal, lateral and rear surfaces identified. The flat fracture surface presumably developed late in flight, modifying the original shape and giving the stone its block-like form.

No well-marked apex is developed on the frontal surface, which is smooth and close-textured, with a few nodular projections of fused nickel-iron. There are a few fine ridges of fused material distributed at random. Faint flow-lines can be seen passing from the frontal to the lateral surfaces. The lateral surfaces show regmaglypts with no marked linear trend. The rear surface shows shallow regmaglypts, and the generally smooth surface possesses areas pitted with small circular depressions. These are well seen under low power microscopic examination (x30). They occur in isolated patches, and with one exception (on a lateral face) are confined to the rear surface. Certain portions of the rear surface show the development of a network of fine cracks. These are well shown on plate 49, A.

G.7346 and G.7347 both show a fusion crust similar to G.7345. Nodules of fused nickel-iron are more common, some of which are broken and appear like burst bubbles.

The Nora Creina stone (G.7579) has a highly scoriaceous crust, the nodular surface being greatly accentuated and producing a stone of markedly different appearance from the remainder of the Lake Bonney group.

Mineralogical Composition

Thin sections cut from four of the five stones have been examined, and the following minerals identified:—

Opaque Minerals:

Nickel-iron: Nickel-iron occurs as irregular branching masses, as grains, and as rims around the chondri.

Troilite: Troilite is present in amoeboid masses and as small grains in all the thin sections studied. The largest mass observed measured 2 x 1 mm. It also occurs in association with chondri as a rim, or partially and sometimes completely enclosed within chondri. Composite grains of troilite and nickel-iron are common.

The opaque minerals constitute approximately 15% of the stones. Troilite is in excess of nickel-iron in the Lake Bonney group, and equal in proportion with nickel-iron in the Nora Creina stone. The smallest stone (G.7347) has very little nickel-iron.

Silicate Minerals:

The silicate minerals, olivine and orthopyroxene, constitute approximately 75%-80% of the stones. Olivine is in excess of orthopyroxene. They occur in both chondri and groundmass.

Olivine: The olivine, which shows little alteration, has a composition of 25 mole per cent $Fe_2Si\,O_4$ (determination by Dr. B. H. Mason, American Museum of Natural History). It is predominant in the Nora Creina stone.

Orthopyroxene: The orthopyroxene is non-pleochroic and has low birefringence. The fibrous structure is well shown in the chondri, and in some individual crystals in composite olivine-orthopyroxene chondri.

Plagioclase feldspar: Single crystals of plagioclase were noted in the stones G.7346, G.7347 and the Nora Creina stone.

Glass: The laths of olivine in the barred olivine chondri are separated by glassy material. Some glass also occurs in veins.

Iron Oxides:

Limonite is present in all the stones, as an oxidation product of nickel-iron, and it occurs in and adjacent to veins. It is most common in the two smaller stones, where it colours much of the thin section.

Opaque material, black under oblique reflected light, is found in veins together with limonite, and also associated with the nickel-iron and troilite. Occasionally it occurs as isolated grains. It is believed to be magnetite. Battey (1962) reports magnetite from the Wairarapa Valley meteorite (New Zealand) and it has been reported from a number of other chondrites.

Chloride:

Lawrencite: (ferrous chloride) was observed as a green exudation on the freshly cut surface of two of the stones.

STRUCTURE

The Nora Creina stone differs from the others of the group in showing well-developed chondri. They are of the following types:—

i. Eccentric radiating chondri of fibrous orthopyroxene.

ii. Granular olivine chondri.

iii. Barred olivine chondri.

iv. Composite olivine-orthopyroxene chondri.

The chondri of the first type are frequently almost spherical in form with clearly defined margins separating them from the matrix. They generally show "brush" or undulose extinction.

The granular olivine chondri are less well differentiated from the matrix, and do not usually show the same spherical outline. The individual olivine grains in the coarser chondri often show subhedral form, and small irregular olivine grains occur commonly between larger grains in the chondrule. In one case two granular olivine chondri are merged together to form a double chondrule shaped like a figure-of-eight. Barred olivine chondri are infrequent. Interstitial material in these forms appears to be glass.

The composite olivine-orthopyroxene chondri comprise alternating prismatic layers of the two minerals, or the chondrule consists of a central section of fibrous orthopyroxene with marginal areas of barred olivine.

Nickel-iron is found incorporated in some of the chondri. Many are partially or completely surrounded by a rim of nickel-iron and troilite. The average diameter of the chondri is 1 mm., the largest being 3 mm.

The matrix consists of an aggregate of granular orthopyroxene and olivine with interstitial areas of nickel-iron and troilite. The Nora Creina stone does not show the brecciation common in many chondrites. Veins are common, frequently showing an anastomosing pattern. They cut both the matrix and the chondri and are filled with iron oxides and glassy material.

The largest stone (G.7345) shows the chondrule types of the Nora Creina stone (with the exception of the barred olivine chondri). However the chondri are less well differentiated from the ground mass into which they tend to merge. One distinctive chondrule consists of a cross-hatched series of ortho-pyroxene laths. This type of micro-structure has been referred to by Krinov (1960) as a complex-grated chondrule.

Chondritic structure is also poorly developed in the other stones of the Lake Bonney group.

CLASSIFICATION

Determination of the olivine composition of the Lake Bonney and Nora Creina stones places them in the group of olivine-hypersthene chondrites (Mason, 1962). The fact that the olivine composition of the Nora Creina stone is the same as that of the Lake Bonney group supports the view put forward in this paper that all the stones form part of the same fall.

CONCLUSIONS

From the available evidence it is concluded that the five stones constitute a fall of stony meteorites in the vicinity of Jacky Point, Lake Bonney. The Nora Creina stone is not believed to have been found *in situ*, and its separation from the remainder of the group by a distance of over 40 miles is thought to be due to removal after fall by natural, or more probably, human agencies.

The differences in structure and external features observed between the Nora Creina stone and the rest of the group are interpreted as resulting from variation in the original meteorite mass before disruption in the atmosphere, and to differences in their terrestrial history. Development of iron oxides is variable within the stones. Two of them, however, show considerable oxidation, which suggests that the fall is not a recent one.

ACKNOWLEDGMENTS

The author extends his grateful thanks to Mrs. B. G. McDonald of Millicent, the discoverer, and to Mr. McDonald, for making the meteorite available for study, and for their hospitality and help in the search for further finds; also to Mr. Dave Schultz of Rendelsham for providing transport and leading a search party into the Lake Bonney area.

Dr. Brian Mason of the American Museum of Natural History kindly made available determinations of the olivine composition incorporated in this paper.

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EXPLANATION OF PLATES 49-51

PLATE 49

A. The largest stone of the Lake Bonney Meteorite group (G.7345). View showing rear surface with shallow regmaglypts, pitting and development of fine cracks. Flat fracture surface shown at base of photograph.

B. Photomicrograph of G.7345 showing orthopyroxene chondrule (diameter 1.5 mm.) in ground mass of nickel-iron and troilite (black), olivine and orthopyroxene. The large white area is a hole in the thin section.

PLATE 50

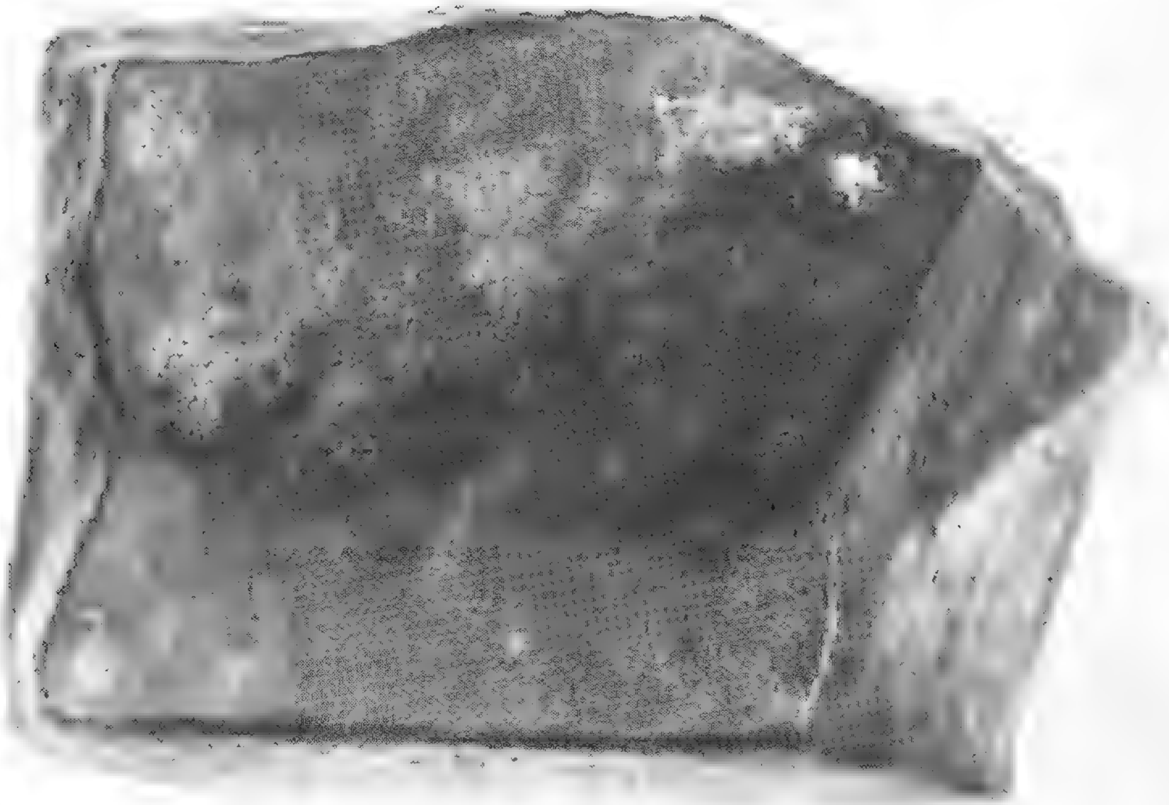
A. Photomicrograph of the Nora Creina Stone (G.7579) showing on the left a granular olivine chondrule with rim of nickel-iron, and a barred olivine chondrule on the right. The latter (long axis 1.5 mm.) is traversed by a vein filled with iron oxides.

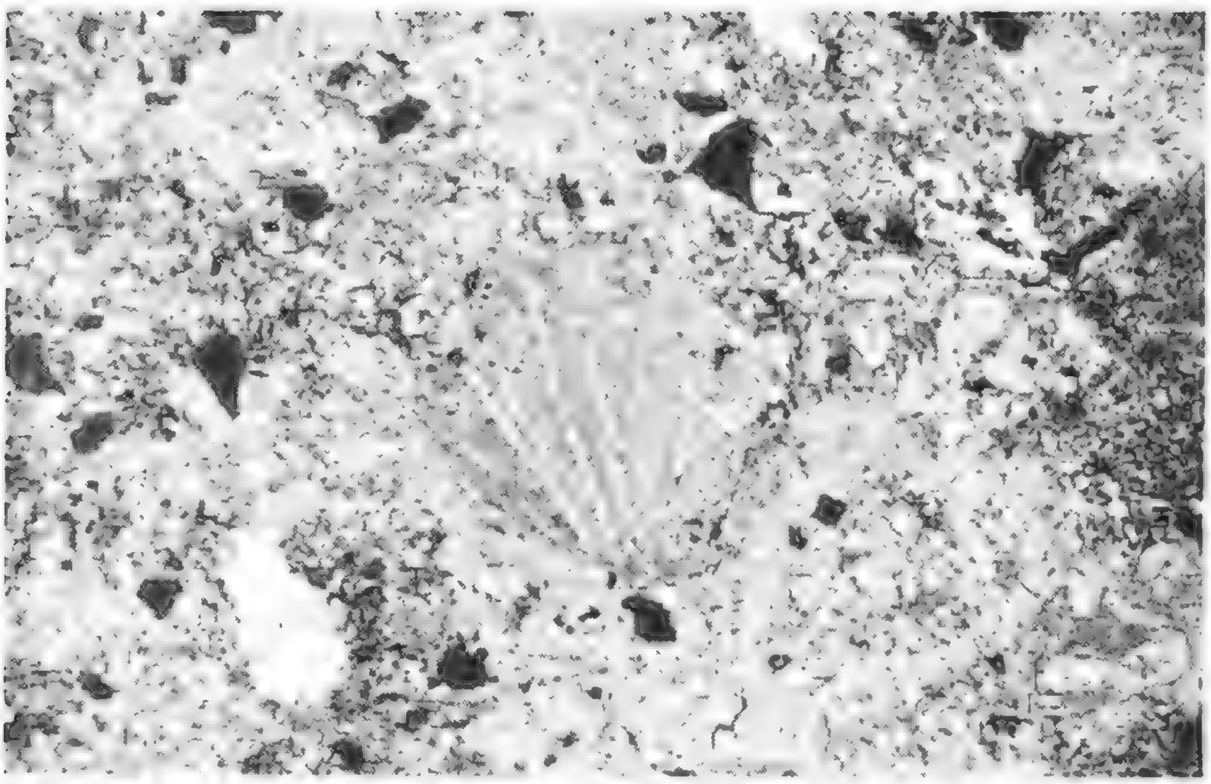
B. Photomicrograph of the Nora Creina Stone (G.7579) (x 40 approx.). A spherical orthopyroxene chondrule, finely fibrous, with small embayments filled with nickel-iron, appears on the left of the photograph; and an eccentrically radial fibrous orthopyroxene chondrule is seen on the right.

PLATE 51

A. Photomicrograph of the Nora Creina Stone (G.7579) showing granular olivine chondrule in the centre (long diameter 1.6 mm.). A composite chondrule (olivine and orthopyroxene) with nickel-iron rim appears at the top right of the photograph.

B. Photomicrograph of G.7347 (x 40 approx.). Chondritic structure is poorly developed. Two chondri of orthopyroxene in the centre of the photograph merge into the ground mass. The black areas are nickel-iron and troilite.





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